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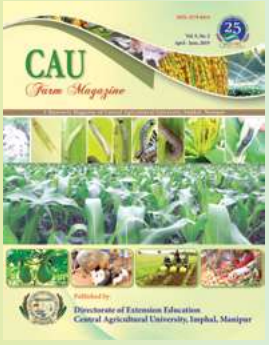

The views expressed in the articles are of the authors and not of the Directorate of Extension Education, CAU, Imphal.

Cover page: Strategies of Fall Armyworm

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From the Editor's Desk

Marching towards the door of end-users with useful technologies of agricultural and allied areas, the Central Agricultural University, Imphal is leading at the national level. As one of the important mandates of the Agricultural University, Extension Education plays a pivotal role to serve the rural people. For this purpose, the publication of CAU Farm Magazine is thought to be effective means to act as a carrier of very useful, time-driven and region-specific technologies/information. Therefore, we use indirect communication and circulation of the Magazine is made to all development departments, KVKs, NGOs and educational and research institutions so that the content/information of the Magazine may reach to the farmers through the extension machinery mentioned above.

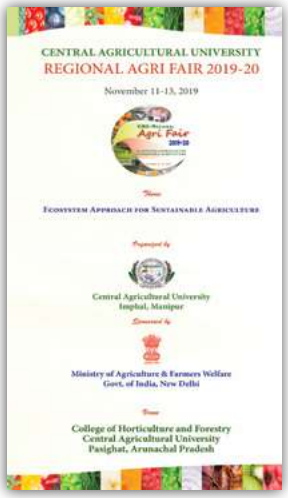
Being a systematized, time-bound and farm-oriented extension literature, this Magazine has been publishing with the urgent, season-based articles contributed by learned scientists and teachers. In this continuous chain, the present issue of the Magazine contains thirteen (13) nos. of verified articles focusing over main staple crop of the region i.e., paddy along with plant protection issues, fall armyworm (FAW) issues, cultivation of chow chow, natural resource management, matters related to climate change, integrated farming, farm mechanization, biofloc technology in aquaculture, different ways to enhance the income of farmers, issues related to animal husbandry and marketing of agricultural produce especially the fruits and vegetables of the north-eastern region. To transmit the valuable information and technical input on the broad areas enumerated above, the role of the contributors of this issue seems of utmost important and all of these think-tanks are cordially thanked on behalf of the whole Editorial Board.

The Hon'ble Vice-Chancellor and Patron of the Editorial Board have the foresight and constructive vision to spruce-up the publication of this Magazine. Therefore, we would like to convey our regards and thankfulness towards this eminent personality of the University.

Further, on behalf of the Directorate and being the Chief Editor of the CAU Farm Magazine, I would like to thank all the members of the Editorial Board, Dr. Angad Prasad, Dy. Director of Extension Education & Editor of the Magazine and Dr. Indira Thounaojam, Information & Publicity Officer working with Editorial Board as Asst. Editor. I also like to thank Mr. Y. Premchand Singh, Computer Operator; Mr. G. Amritkumar Sharma, Video- photographer, Mr. Rahulnath Sharma, and all other staff who have contributed to their level best to bring this issue on time.

Lastly, I would like to opine by heart that the response from all the readers and stakeholders of farming occupations will be an impetus to sustain our interest. Viewing this idea, I hope that the present issue of CAU Farm Magazine (Vol. 9, No. 2) will be liked by all the valued readers.

(Prof. Ratan Kumar Saha)
Chief Editor



UPCOMING EVENTS

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&

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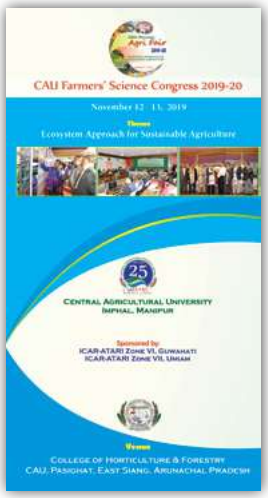

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INTEGRATED MANAGEMENT STRATEGIES OF FALL ARMYWORM (FAW), *SPODOPTERA FRUGIPERDA* ON MAIZE

Nabakishor Nongmaithem[1], Sanjenbam Dayananda[1], Jeti Konsam[1], Pushparani Senjam[1], Thiyam Rebika[2] and Kh. Ibohal[2]
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Fall armyworm (FAW), *Spodoptera frugiperda* of Noctudae family is a highly polyphagous migratory lepidopteron pest species that refers the invasive behaviour of larvae native to tropical and subtropical region of America causing significant damage to crop. It was detected in Central and Western Africa in early 2016. Adult's strong flying ability of 100 km/night and high fecundity with adult female laying 1000 egg producing 10 batch average of their 10-20 days lifespan.

FAW is threatening and major concern to researcher spreading all over the world, recently invaded India and presently causing economic damage in maize. The incidence of this pest was first observed in Shivamogga district, Karnataka on 18th May 2018 and subsequently reported in Tamil Nadu, Andhra Pradesh, Telangana, Maharashtra, Madhya Pradesh, Odisha, Bihar, West Bengal, Gujarat, Rajasthan, Kerala, and Uttar Pradesh at mild to alarming levels in farmer's fields. By January 2019, Chhattisgarh was the last state to report the pest. In northeast India, this invasive pest was reported for the first time during late March 2019 in Lunglei district of Mizoram and West Tripura district of Tripura. Subsequently, it has detected causing massive outbreaks during April in Mizoram and Nagaland. Later, it was detected causing damage to maize crop during early May in Meghalaya, Manipur, Sikkim and Arunachal Pradesh of northeast India. FAW was first detected in Manipur on 7th May, 2019 in Chandanpokpi village of Chandel district and subsequently reported from all the districts of Manipur. The pest is suspected to have arrived from Myanmar via Chandel district of Manipur, which borders Myanmar.

FAW attacks more than 180 spp. of plant in 42 families. However, this species prefers corn, sorghum, bermuda grass which are C4 plant as opposed to cotton, soybean. Within the Noctudae family fall armyworm, corn earworm and true armyworm are very identical except that FAW has four black spots arrange in square shape in 8th abdominal segment and in trapezoid manner in 9th abdominal segment and marked with a white inverted 'Y' shaped on its head. The adult male moths have grayish-brown molted forewing light and dark splotches and female adult having noticeable spot near the extreme end of each forewing, the hind wing is iridescent silver white with narrow dark border. FAW can't tolerate prolonged freezing temperature and this species doesn't enter diapauses stage. Fall armyworm currently undergoing divergence into two separate species, R-strain which prefer rice (*Oryza sativa* L.), Bermuda grass and other Graminae where C-strain prefers cotton and corn (*Zea mays* L.)

SYMPTOMS ACCORDING TO THE STAGE OF LARVAL INSTARS

Fig. 1 Egg mass of FAW

Fig. 2 First instar larvae

Fig. 3 Initial symptoms (Papery window)

Fig. 4 Damage caused by 2nd instar larvae

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Fig. 5 Ragged-edged holes caused by 3rd and 4th instar larvae

Fig. 6 Extensive leaf damage caused by 5th instar larvae

Fig. 7 Damage caused by 6th instar larvae

Fig. 8 Larvae damaged on tassel

Fig. 9 FAW damage the reproductive stages

Fig. 10 FAW damage the maize field

Fig. 11 FAW Larvae

Fig. 12 FAW 5th instar larva with identification marks viz., three creamy yellow lines (2, 3 & 4), white Y-shaped suture(1), bigger spots arranged in square (5) and trapezoid (6) formation.

Male and female moths

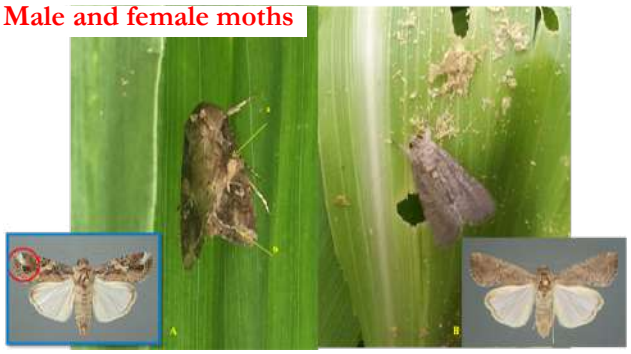

Fig. 13 Male moth (A) has fawn coloured spot (a) and whites a patch (b) at the apical margin of the wing. Female (B) is dull with faint markings

Life cycle of Fall armyworm

Fall armyworm life cycle includes egg, six instars caterpillar stage, pupae and adult. Duration of life cycle varies with climatic and other conditions such as life cycle completed within 30 days during summer, 60 days in spring, autumn and up to 80-90 days during winter season.

Fig. 14. Life cycle of Fall armyworm

Integrated pest management (IPM) strategy for Fall armyworm

Monitoring

Installation of FAW pheromone traps @ 5 acre^{-1} on or before germination of the crop to monitor pest and population build-up. If 3 moths are detected per trap spraying is recommended.

Fig. 15 Pictorial representation of Scouting

Scouting

1. Start scouting in **"W"** pattern in the field after leaving 3-4 outer rows as soon as maize seedlings emerge
2. **At Seedling to early whorl stage** (0-2 weeks after emergence). Action can be taken if 5% plants are infested or first catch of 3 moths trap^{-1}.

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3. **At Early whorl to mid-whorl stage** (2-4 weeks after emergence). Action can be taken if 5-10% plants are infested.
4. **At Mid whorl to late whorl stage** (4-7 weeks after emergence) - Action can be taken if 10% whorls are freshly damaged in mid whorl stage and 20% whorl damage in late whorl stage.
5. **Late-whorl stage** (7 weeks onwards of emergence) - Action can be taken if more than or equal to 20% plants are infested.
6. **At tasseling to harvest stage-** Do not spray any insecticides (No insecticide application), but manually pick and destroy larvae.

Fig. 16 Pictorial representation of Scouting

Cultural measures

1. Deep summer ploughing is recommended before sowing to expose FAW pupae to predatory birds and heat.
2. Timely sowing is recommended and avoids staggered sowings (Planting in same field at different times).
3. Follow clean cultivation and balanced use of fertilizers.
4. Intercropping of maize with non host crop (eg. Maize + pigeon pea/black gram /green gram).
5. Erection of bird perches @ 10 acre^{-1} as soon as sowing is completed (up to 30 days).
6. Planting of 3-4 rows of Napier grass (FAW trap crop) in maize field and spray with 5% NSKE or azadirachtin 1500 ppm @ 5 ml l^{-1} as soon as the trap crop shows symptom of FAW damage.
7. Selection of single cross hybrids and planting of maize hybrids with tight husk cover will reduce ear damage by FAW.

Mechanical Measures

1. Hand picking and destruction of egg masses and neonate larvae in mass by crushing or immersing in kerosine water. OR

   Picking of FAW larvae and feed them to chicks for poultry production as FAW larvae are good complementary source of protein. OR

   FAW are also edible for human consumption. In countries where insects are consumed, they are good complementary source of protein for local population.

Fig. 17 Collection of warms

2. Application of sand or ash into plant whorl of affected maize plants soon after observation of FAW incidence in the field.

Fig. 18 Application of sand or ash into plant

3. Application of soil or soil slurry to the leaf whorl

Fig. 19 Application of soil or soil slurry to the leaf whorl

4. Mass trapping of male moths by using pheromone traps @15 traps acre^{-1}

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Fig. 20 Pheromone traps in the field

Biological Control strategies

1. ***In situ* protection of natural enemies by habitat management**

   Increase the plant diversity by intercropping with pulses and ornamental flowering plants which help in build-up of natural enemies.

2. **Augmentative release of *Trichogramma pretiosum* or *Telenomus remus*** @ 50,000 acre^{-1} at weekly intervals or based on trap catch of 3 moths trap^{-1}.

Fig. 21 *Telenomus remus* on FAW eggs

3. Microbial Biopesticides

Microbial biopesticides are suitable at 5% damage in seedling to early whorl stage and 10% ear damage with entomopathogenic fungi and bacteria.

Microbial Biopesticide Formulations

a. Application of *Metarhizium anisopliae* talc formulation (1 × 10^8 cfu g^{-1}) @ 5 g l^{-1} whorl application at 15-25 days after sowing. Another 1-2 sprays may also be given at an interval of 10 days depending on pest damage. **OR**

b. Application of *Nomuraea rileyi* rice grain formulation (1 × 10^8 cfu g^{-1}) @ 3 g l^{-1} whorl application at 15-25 days after sowing. Another 1-2 sprays may also be given at an interval of 10 days depending on pest damage. **OR**

c. Application of *Bacillus thuringiensis* v. *kurstaki* formulations @ 2 g l^{-1} (or) 400 g acre^{-1}

Fig. 22 *Metarhizium anisopliae* infected FAW

Fig. 23 *Nomurea releyi* infected FAW

Chemical control according to stage of crop

1. Seed treatment

Seed treatment with Cyantraniliprole 19.8% + Thiomethoxam 19.8% @ 4 ml kg^{-1} of seed reported to offer protection upto 2-3 weeks after germination.

2. Seedling to early whorl stage (0-2 weeks after emergence): To control FAW larvae at this stage or at 5% damage, spray 5% neem seed kernel emulsion (NSKE) or Azadirachtin 1500 ppm @ 5 ml l^{-1} of water to kill eggs and neonate larvae.

3. Early whorl to mid-whorl stage (2-4 weeks after emergence): To manage 1st instar (3mm) larvae at 5-10% damage spray Chlorantraniliprole18.5% SC @ 0.4 ml l^{-1} or Thiamethoxam 12.6% + lambda cyhalothrin 9.5% @ 0.25 ml l^{-1} of water or Spinetoram 11.7% SC @ 0.5 ml l^{-1} of water.

4. Mid-whorl to late whorl stage (4-7 weeks after emergence): To manage 2nd and 3rd instar larvae at 10-20% damage spray Chlorantraniliprole18.5% SC @ 0.4 ml l^{-1} or Thiamethoxam 12.6% + lambda cyhalothrin 9.5% @ 0.25 ml l^{-1} of water or Spinetoram 11.7% SC @ 0.5 ml l^{-1} of water.

5. Late-whorl stage (7 weeks onwards of emergence): Poison baiting is recommended for late instar larvae i.e. from 4th to 6th instars larvae. Keep the mixture of 10 kg icarb just half an hour before application in the field. The bait should be applied into the whorl of the plants.

6. Tasseling stage to harvest: At this stage hand picking and destruction of the larvae is advisable. Insecticide management will not be cost effective.

Important Consideration

1. Farmers should visit fields twice a week during vegetative stage, especially in the period of heavy oviposition by FAW, and once a week or every 15 days in later stages.

2. Timing is very critical for the control of Fall armyworm (FAW).

3. Timely application of insecticides is recommended in order to prevent the spread of insect from abandoned crop.

4. All the insecticides sprays should be directed towards leaf whorl and either in the early hours of the day or in late evening hours.

5. Creation of awareness among important stake holders through training/ groups discussions

6. Community- based and area-wide approach for implementing management strategies.

Fig. 24 Spraying of Insecticides

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BETTER YIELD OF PADDY THROUGH STAGGERED TRANSPLANTING USING VARIETY 'GITESH'

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Rice is the major staple food and a mainstay for the people of Garo Hills and their food security. It is most abundantly grown in low lying areas of most parts of West Garo Hills district, Meghalaya under rainfed condition. But the productivity of rice in the district is decreasing every year due to growing of long duration, tall and old seedlings (30-45 days) with the change of climate and lack of technical knowledge about new techniques of paddy cultivation. The local farmers faced certain persistent problems in cultivation of paddy such as soil moisture stress due to erratic and inadequate rainfall, disease and pest infestation, excessive weeds, nutrient deficiencies, flash floods, water logging/ submergence due to poor drainage, low-lying physiographic and high rainfall in submergence prone lowlands etc. Besides, the non-availability of improved seeds in time and continuous use of traditional varieties, the farmers do not get the desired yield of paddy. In such a situation, an innovative technique of rice cultivation without reducing the productivity is the need of the hour.

Problem Identified & KVK Intervention

Agriculture is highly dependent on climate patterns and variations. Rainfall is one of the key climate parameters for rice cultivation because large volumes of water are needed to produce rice. The productivity has direct dependency on rainfall received during the crop season with low and excessive rainfalls for negative impact on rice. The farmers borne loss due to late transplanting with old age of seedling due to less rainfall, inadequate moisture and water at the time of transplanting and excessive rainfall during the tillering stage caused submergence and damages the crop. In this situation, technological intervention on staggered transplanting of paddy using high yielding variety Gitesh was demonstrated by ICAR, KVK, West Garo Hills at Marapara village covering a total area of 7.25 ha benefitting 37 farmers under NICRA Project during *Kharif* season, 2015-18. This staggered planting of paddy variety "Gitesh" can be transplanted upto 60 days old seedling with 7-10 days water submergence after properly established. Training programmes and method demonstrations were done to enhance the knowledge and skill of farmers for seed requirement, time of transplanting, spacing, nutrient management, plant protection measures and time of harvesting etc. Field days were also organised to showcase the performance of the technology to the nearby farmers and extension personnel to accept, convince and disseminate the technology to other farmers of Garo Hills.

Output & Outcome

The introduction of short duration high yielding paddy variety 'Gitesh' was enabling the small and marginal farmers to reap good harvest with changing climate of more drought and floods in Garo Hills. The result revealed that an average yield of 3.92 t ha^{-1} was recorded with Gitesh variety which showed an increased in yield of 89.3% compared to local traditional cultivar. The highest yield of 4.22 t ha^{-1} was recorded in the year 2017, which had set a record yield in the area of Marapara village and lowest of 3.55 t ha^{-1} in 2014. The farmers' fetched an average net return of Rs. 19,228 ha^{-1} with high profitability (BC ratio) ranges from 1.87 to 2.07 with average profitability ratio of 1.96 (Table 1).

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Table 1 Average yield performance of paddy variety 'Gitesh' demonstrated at Marapara village, West Garo Hills, Meghalaya (2014-2018)

Year	Variety	Area (ha)	Beneficiary (No.)	No. of tillers/ hill	Grains/ panicle	Days to harvest	Yield (t ha^{-1})	Increase in Yield (%)	Net return (Rs.)	B:C ratio
2014	Gitesh	0.50	2	16	153	124	3.55	67.4	17250	1.94
	Local (Var. Champali)	0.25	2	11	112	146	2.12		7700	1.57
2015	Gitesh	1.22	5	18	149	130	3.70	89.7	17220	1.87
	Local (Var. Champali)	0.25	2	10	123	150	2.00		5900	1.41
2016	Gitesh	1.50	8	19	210	129	4.10	120.4	21200	2.07
	Local (Var. Champali)	0.25	2	11	119	147	1.86		4400	1.30
2017	Gitesh	1.85	10	21	246	149	4.22	94.4	21420	2.03
	Local (Var. Champali)	0.25	2	12	132	149	2.17		6840	1.46
2018	Gitesh	2.18	12	21	232	129	4.05	84.0	19050	1.89
	Local (Var. Champali)	0.25	2	12	145	156	2.20		7200	1.48
Total/ Average	Gitesh	7.25	37	19.0	198.0	129.4	3.92	89.3	19228	1.96
	Local (Var. Champali)	1.25	10	11.2	126.2	149.6	2.07		6408	1.45

Fig. 1 Nursery of paddy (Gitesh)

Fig. 2 Demonstration Plot

Fig. 3 Field Day

Impact and Feedback

Paddy variety 'Gitesh' is gradually attracting farmer attention and more and more farmers are encouraged and approaching the KVK for help to demonstrate on their own farms to cope with natural calamities like water stress, terminal drought, flash floods. The farmers were satisfied and found to prefer the staggered planting rice 'Gitesh' due to flexibility in seedling age, transplanting time, higher productivity, food security and increased income to farmers. Farmers were very grateful to KVK, West Garo Hills and expressed to enhance the resilience to agriculture with dissemination of this paddy variety in and around the villages of Garo Hills, Meghalaya. The hardworking and success of all the selected beneficiaries has encouraged other farmers to produce more rice using improved variety which has high income generation for livelihood and they themselves encouraged from their achievements and interested to expand more cultivation in future. KVK, West Garo Hills will extend suitable support and encouragement for them in future. Horizontal spread of the technology to five different villages of West Garo Hills district covering 15.50 ha and benefitting 23 numbers of farmers.

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CHOW CHOW *(SECHIUM EDULE)*: A MULTIPURPOSE VEGETABLE CROP AND ITS CULTIVATION PRACTICES

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Chow Chow belongs to Cucurbitaceae family originated from Mexico and Latin America. The crop is known by different names such as vegetable pear in America, "Isqush" in Nepal and North East India, Chayote in India. It is an underutilized vegetable crops which is known for its versatility because its tender shoots, fruits and tubers are eaten as vegetable by different tribes all over the world. Chow Chow cultivation is widely distributed throughout India it is mainly cultivated in Sikkim, Darjeeling, Mizoram, Manipur, Nagaland, Arunachal Pradesh, Himachal Pradesh, Tamil Nadu, Karnataka, Kerela etc.

Uses

Chow Chow is known for multipurpose vegetable as its tender shoots, fruits and tuberous are eaten as vegetables and they have their own delicacy.

1. Tender Shoots

Once the vegetative growth starts a vine produce profuse shoots that are harvested by pinching off tender ends and are cooked and served with steam rice or chapatti. Tender shoots are generally available during April –June. In local market it is sold at Rs. 30 bundle^{-1}.

Fig. 1 Fresh

Fig. 2 Cooked

2. Fruits

Fruiting starts during July-August which reaches full size in about 25-30 days after pollination. A single vine may produce up to 200 fruits or more. Both mature and immature fruits are suitable for culinary purpose. Generally immature fruits fetch good price in market i.e. Rs. 50 kg^{-1}.

Fig. 3 Fruits on vine

Fig. 4 Fruits after harvest

3. Tuberous root

The underground roots which attains economic size after 2- 3 years of planting, which can be harvested by digging the soil around growing point. Size of the tuberous roots varies according to growing condition and nutrient supply to the vine. It can be used like potato and serve with rice or chapati. Generally it is sold at around Rs. 120- 150 kg^{-1} at peak season.

Fig. 5 Tuberous root

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Table 1 Chemical composition of chow chow fruit

Nutrient	Value
Energy (kcal)	19
Carbohydrate (g)	4.51
Protein (g)	0.82
Total fat (g)	0.13
Dietary fiber (g)	1.7
Vitamins	
Niacin (mg)	0.470
Pantothenic acid (mg)	0.249
Pyridoxine (mg)	0.076
Riboflavin (mg)	0.029
Thiamin (mg)	0.025
Vitamin A (IU)	0
Vitamin C (mg)	7.7
Vitamin E (mg)	0.12
Vitamin K (ug)	4.1
Minerals	
Calcium (mg)	17
Iron (mg)	0.34
Magnesium (mg)	12
Manganese (mg)	0.189
Phosphorus (mg)	18
Selenium (ug)	0.2
Zinc (mg)	0.74

(Source: USDA National Nutrient data base)

Health Benefits

- It is rich a source of dietary fiber, anti-oxidants, minerals, vitamins and less calories which can control cholesterol helps in weight reduction.
- Terpenes and flavonoid present in chow chow possess anti-cancer activity.
- It possesses anti-viral, anti- bacterial, and anti-fungal activities.
- It has protective effect on heart, blood vessels and skin.
- It is also good for diabetic people
- It also controls high blood pressure.
- Its effectiveness in curing kidney diseases has been known since ages.
- It relieves constipation and ease in bowel movement.

Plant Morphology

Chayote is a perennial, monoecious vine that climbs on support by clinging with tenacious tendrils and will renew its growth from the roots each year if protected from freezing. The vine resembles like cucumber, but is much vigorous in growth and more prolific in fruit production. Vegetative flush produce profuse young shoots and leaves which are tender, fleshy and delicious. It bears different types of fruit. They differ in color, size, surface, form and quality of flesh. They range from dark green to ivory-white, fruit size varies from 5-20 cm in length and 150 g - 1 kg in weight, fruit surface varies from a smooth to a deeply wrinkled; from non-prickly to very prickly skin and from round to a flattened pear shape. Chow Chow is only cucurbitaceous species which bears single seeded fruit. Fruits are viviparous in nature, the seeds germinate once fruits get matured even when it is still on the plant. Perennial vine also produce tuberous root which are edible, fleshy and mild in taste.

Cultivation Practices

Climatic: It is a warm season crop can be grown in both tropical and subtropical climate preferably between 800 and 1800 m altitude. The optimum temperature for fruit growth and development is 21- 30° C. It is a long day plant so it requires of 10-12 h of light for normal flowering and fruiting. Frost is limiting factors for its cultivation.

Soil: It will grow in diverse soil types, but will do best in a rich, fertile, well-drained high in organic matter. Chow Chow is slightly tolerant to acid soil (pH < 5.5) ideal soil pH is 5.5-6.5.

Propagation: Whole fruit is used as propagating material.Fully matured and sprouted fruits collected from high yielding vines are planted in pits @ 2 – 3 pit^{-1}

Planting: It is usually planted in the spring after the danger of frost is over generally during April – May with assured irrigation facility. Plough the soil properly. Dig pits of 45 cm x 45 cm x 45 cm at a spacing of 2.4 x 1.8 m and fill up the pits with 10 kg of FYM, 250 g of urea, 500 g of Super phosphate and 500 g of Muriate of Potash.

Irrigation: Light irrigation should be provide immediately after planting. Irrigation is critical during the dry periods to keep the plant growing through the summer and to help the plant hold its fruit and increase the size of developing fruit.

Mulching: Provide a thick, but loosely packed mulch of hay, leaves or similar material during winter to

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prevent from frost damage.Mulching will also help to hold the soil moisture around the shallow root system.

Vines Support: Chow Chow vines need support on which they climb. Commercial growers use large "T" trellises or pandal that furnish plenty of space to most of its growth. Bamboo poles are generally used to make trellis/bower/pandal for vines to trail over the height of 2 meters.

Pruning: The vines dries up after the fruiting season is over during winters. Vine should be pruned leaving only small portion of about 1.5 m stem on its growing point. Mulching after pruning is essential to prevent from winter frost and allow the plants renew its growth from the roots in each year.

Nutrient management: Chow Chow (chayote) is a vigorous vine with shallow roots and a heavy feeder crops. Plant respond well on well rotten FYM and application of @ 20- 30 kg^{-1} vine givers excellent results. Commercial fertilizer can also be used like ammonium nitrate, 250 g of urea for each vine after pruning and at the time of flowering.

Plant Protection

Pests: For controlling scales, mealy bugs and aphids spray Dimethoate 30 EC @ 1 ml l^{-1} to control fruit fly collect the damaged fruits and destroy.The fly population is low in hot day condition and it is peak in rainy season. Hence adjust the sowing time accordingly.

Diseases: Mosaic is reported from the chayote field. Vectors can be controlled by spraying Dimethoate 30 EC 2 ml l^{-1} or Methyl demeton 25 EC 2 ml l^{-1} thrice at fortnightly intervals.

Yield: Yield varies according to growing condition and management practices. Generally about 30 - 35 t ha^{-1} can be obtained.

Future Prospects for Crop Improvement

In spite of the fact that the Chow Chow plant has multiple uses (different plant parts) but still these uses have not become widespread and accessible to many population other than the tribal community.To intensify and diversify theproduction of Chow Chow following points have to be included in the future plan:

- The establishment of permanent gene banks in several localities to maintain varietal diversity, wild populations and related species. These collections can be used to evaluate resistance to diseases, type of growth and organoleptic characteristics of the fruit. They will allow growers to be supplied with new sowing material and will be used as a basis for genetic improvement.
- Programmes for selecting varieties with a high root yield or a high production of young stems. Both are popularly accepted consumer items, with a high nutritional value and potential use as a basic material in agro industries.
- The development of vegetative propagation methods that will provide growers with sowing material at reasonable prices.
- Basic studies on the plant protection measures has to be done to prevent the crop from pest and diseases.
- Identification of problems in postharvest handling, packaging and storage during the marketing process.

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ENHANCING INCOME OF FARMERS THROUGH LIVESTOCK INTERVENTIONS IN WEST GARO HILLS OF MEGHALAYA- Success Stories

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Dairy farming is one of the integral parts of Integrated Farming System, which came out very successful in different parts of the country. But, unfortunately dairy farming practices is not that much popular in Garo Hills. Due to lack of improved breed in the area and lack of knowledge of improved dairy farming practices, it was comparatively less remunerative for the farmers in Garo Hills. A sincere effort was made at Sanchonggre village of Rongram Block of West Garo Hills district, Meghalaya, which is situated about 20 kms from district head quarter Tura. In an effort to build capacity of rural tribal farmer under TSP, one capacity building programme on "Scientific Dairy Management" was organized on 8th March, 2017, jointly by College of Community Science, Tura and College of Post Graduate Studies in Agricultural Sciences, Umiam, Central Agricultural University (Imphal) at Tura, Meghalaya.

Success Story - 1

Mr. Rahendro A. Sangma, aged 36 years, a farmer of having 5 bigha of agricultural land and five family members of Sanchonggre village was given one dairy cattle. Performance of dairy cattle was regularly monitored and frequent visits and telephonic calls (Whatsapp) by the faculties of CAU (Imphal). After a period of one year and total investment of Rs. 36,000 (@ Rs. 3,000 month^{-1}) towards dairy feeds and veterinary aids. Mr. Sangma sold 8 liters of milk per day @ Rs. 47 l^{-1} to Central Dairy Farm (Megha milk), Govt. of Meghalaya and total income of Rs. 11, 280 (Rupees eleven thousand two hundred eighty only) per month towards selling of milk. He earned a net profit of Rs. 8,280 month^{-1} towards selling of milk. On an average he earned a net profit of Rs. 99,360/-within a year. He is presently continuing dairy farming for improving his livelihood status. It helped him in substantial increase in his annual family income and inclusion of dairy based farming system module helped him to get more livelihood generation opportunities.

Success Story - 2

Similarly, Mrs. Esadina N. Sangma, a farm women of 40 years of age at Dumitdikgre village of Rongram Block of West Garo Hills district, Meghalaya also came out a successful dairy farm women after the intervention of TSP programme in the block. Esadina Mrs. Sangma has 7.5 bigha of agricultural land and seven family members and she was given one improved breed of dairy cattle. Performance of dairy cattle was regularly monitored and frequent visits and telephonic calls (Whatsapp) by the faculties of CAU. After a period of one year and

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total investment of Rs.48,000 (@ Rs. 4,000 month^{-1}) towards dairy feeds and veterinary aids. Mr. N. Sangma also sold 7 liters of milk per day @ Rs. 47 l^{-1} to Central Dairy Farm (Megha milk), Govt. of Meghalaya and total income of Rs. 9,870 (Rupees nine thousand eight hundred seventy only) per month towards selling of milk. She earned a net profit of Rs. 5,870 month^{-1} towards selling of milk. On an average she earned a net profit of Rs. 70,440 within a year. At present, she is continuing dairy farming and compost making for improving her livelihood status. This initiative came out as success story of tribal women empowerment through TSP intervention.

Pig Farming

Pig farming is the most popular farming practices under Integrated Farming System in Garo Hills. Farmers usually rear local breeds rather than exotic breed because of higher demand of local breeds among the tribal people for local delicacy. But, local breeds are found very often non-remunerative due to less growth and lower fecundity rates. Hence, under TSP project improved breed were distributed among the selected farmers at Sanchonggre village of Rongram Block of West Garo Hills district, Meghalaya situated about 20 kms from district head quarter Tura. In an effort to build capacity of rural tribal farmer under TSP, one capacity building programme on "Scientific Piggery Management" was organized on 08.3.2017, jointly by College of Community Science, Tura and College of P G Studies in Agricultural Sciences, Umiam, Central Agricultural University (Imphal), Meghalaya.

Success Story

Mr. Molen T. Sangma, aged 40 years, a farmer of having 2 bigha of agricultural land and five family members of Sanchonggre village was given one piglet of 4 months old brought from NRC Pig, Rani. Performance of piglet was regularly monitored and frequent visits and telephonic calls by the faculties of CAU. After a period of one year and investment of Rs. 6,000 towards feeds and veterinary aids. Molen T. Sangma sold 10 (ten) piglets at the rate of Rs.3,000 piglet^{-1} and total income of Rs. 30,000 (Rupees thirty thousand only). He earned a net profit of Rs. 24,000 towards selling of piglets. He is currently continuing pig farming for improving his livelihood. It helped him to enhance his annual family income.

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FARMING IN A CHANGING CLIMATE: Addressing the Issue in Meghalaya

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During last few years, ample of literatures have surfaced out discussing the emerging importance of climate change at the global and national level. Workshops, seminars, debate and brain storming sessions have been organized at various platforms where, there is exchanged of information among the scholars and policy makers addressing the how and why of climate change. The intensity of the extreme events like floods, hailstorm, cyclone, and drought etc. have risen over the years. Months ago, two metropolitan states of India, Kerela and Odisha had experiencesthe devastating effect of flood and cyclone. These have brought various destruction to lives, habitation and the development as a whole. Restructuring what was loss cause a huge economic investment. Scholars through various sources remarked that many parts of the country face severe drought which adversely affect people's way of life and farming besides causing various health deterioration. The India Meteorological Department (IMD) annually has estimated and forecast the quantum of rainfall in the country and in the recent years deficit in monsoon rainfall has been reported to a large extent.

The deviation in climatic factors in this decade has been evidently remarked by various findings as much variation in comparison to the past decade. It is also forecast, that the changes will be more distinct in the upcoming decade be it with the high intensity or low quantum of rainfall or with the change in temperature. It is well documented that among the various sectors, agriculture is the most vulnerable towards the change as the sector is highly dependent upon the climatic factors, rainfall and temperature as basic inputs.

Farming is the main livelihood of more than 70% of the people in India. The share is similar in the North Eastern states of the country particularly among the rural section. Studies revealed that people from all walks of life have clearly perceived the irregular timing of rainfall and variation in temperature. Meghalaya is no exception to the change where the major section of the farming community remarked that farming is directly hit by the change in climate. The change in timing of arrival of monsoon rainfall in particular and increase in summer temperature have been perceived by the farmers across the hills of Khasi, Jaintia and Garo elites. Certain parts of Ri-Bhoi district have experienced a vast destruction on farming due to heavy hailstorm that eventually arrives in the month of April since last 2-3 years. In the year 2018, hailstorm in Umeit village in the district in the month of October caused a heavy loss to the rice growing farmer which is on the stage of ripening.

The Southern and Western parts of the Khasi hills reportedly encounter cyclone over the years. Paradoxically, the State inhabits the heaviest rainfall region in the world, Mawsynram and Sohra (Cherrapunji) which receive an annual rainfall of more than 10000mm. However, these regions have been found to suffer from drought during the pre and post monsoon periods. These forms of irregularities brought farming at the verge of unsustainability.

Lack of external sources of irrigation prompted the farmers to substantially dependent on rainfall for farming. So, the success of farming is at the mercy of climate. However, the farmers have reported the delay in onset of monsoon rainfall in the state. This has affected the cultivation of water loving crop like rice. The delay of onset of monsoon lead to the postponing of the transplanting time of rice and this ultimately affected the proceeding stages of crop

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growth. There also reported aberration in the quantum of rainfall, where the farmers experience deficit rainfall during critical water requirement stages of rice and flood like situations when the crop approaches the harvesting period.

The drastic drop in rice productivity lower the income of the farmers and also cause a loss in soil fertility over the years. Restoring the soil fertility by means of increasing the doses of fertilizers is a costly effort in terms of soil health and investment. Heavy infestation of crop pest and diseases has been reported in various crops and notably some pests have already developed a resistant to certain insecticides. The costs of cultivation of crops have increased over the years and in a situation where product pricing is marginal, farming fail to offer a profitable return.

It is critically high time to safeguard farming from these destructive and drastic changes of climate. The Central Government has incorporated climate change issue in its various policy framework. One of the viable options is the Pradhan Mantri Fasal Bima Yojana (PMFBY) crop insurance which was implemented during 2015. This insurance scheme can protect farming in a long run, but statistics has revealed that the North Eastern states could reap only minimal benefit from the scheme and some states have not even enroll itself under the scheme. This calls for awakening the function of the states Government in the region. The states across the country have also frame the State Action Plan on Climate Change (SAPCC) as a replica of the National Action Plan on Climate Change (NAPCC). The Indian Council of Agricultural Research (ICAR) has implemented a nationwide project NICRA (National Innovation on Climate Resilient Agriculture) as a means of adopting the cluster of affected villages due to climate change. Under NICRA various components has been identified where demonstration of climate resilient technologies is the key component.

Farmers' adaptation to the change in climate is the first step of safeguarding farming. Awareness on the change in climate is the need of the hour. As the change cannot be controlled however, loss can be prevented to some extent by changing the farming practices from the normal. Below are the ways which farming can be better:

1. Selection of seeds/varieties: Proper selection of seed is the pre-requisite for optimum production. Cultivation of varieties tolerant to crop pests and diseases may to some extent safeguard the crop loss.

2. Crop diversification: Diversification of cropping reduces the extent of losses faced by the farmer in an event of crop failure. It helps in minimizing the loss in nutrient content of the soil as nutrient requirement varies across the crop type. Diversifications enrich the nutritional need of the people and maintain food security.

3. Increasing the cropping intensity: Monocropping is generally practiced across rice field the state where after harvesting of rice the field is left fallow. Cropping in the fallow field using moisture conservation techniques like zero tillage, raised and sunken bed could help the proper use of available moisture in the soil from proceeding crop. The labour requirement in these growing techniques is also comparatively lesser. Growing of leguminous crop like pea, bean and other like rapeseed mustard is highly recommended along these fallows field. Besides enhancing the income of farmers, it also helps in fixing nitrogen fertilizers in the soil.

4. Crop residue management: Crop residue management through conservation agriculture (eg., mulching) can improve soil productivity and crop production by maintainingthe soil organic matter level.

5. Integrated Farming System (IFS): IFS is one of the viable options for modern farming. The resource use efficiency in this system is high in comparison to sole cropping. IFS has emerges as the viable form of farming which can lead farming to a business mode and create an employment opportunity where whole family can be involved. Fish cum poultry IFS is one of the finest model adopted in various parts of North East India. Other components like piggery, mushroom cultivation, bee keeping can be successfully incorporated in the IFS model.

Conclusion

Farmers' traditional agricultural practices need to be incorporated along with scientific farming methods to maintain the sustainability of agriculture. Along with the role play by the concern State department is crucial particularly in policy relating to irrigation. Timely supply of recommended seed and crop varieties will increase the rate of adoption of the same. At the foremost, Pradhan Mantri Fasal Bima Yojana crop insurance scheme needs to be implemented in a real manner for farmers benefit.

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INTEGRATED WEED MANAGEMENT WITH IMPROVED FARM EQUIPMENTS FOR ENHANCING AGRICULTURAL PRODUCTION IN NE REGION

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India loses crops of 11 billion dollar due to weeds in main crops. The cost of weeding touches 33-37% and mechanical weeding can save 70% cost as compared to traditional manual weeding using *khurpa or kudal* out of total cost of cultivation. In traditional method farmers engaged 240 man-h ha^{-1} in single weeding operation and there is no option left to pay higher wages of Rs. 7200 ha^{-1} for single operation.

Weeds compete with crops for water, nutrients and light. Being hardy and vigorous in growth habit, they grow faster than crops and consume large amount of water and nutrients, thus causing heavy losses in yields. Weeds increases in the cost of cultivation. Tillage operations are done to control weeds and it is generally estimated that on an average about 30 percent of the total expenditure for crop production is on tillage operations and more labour is employed for weeding. This results in increasing cost of cultivation and reducing the margin of net profit.

Reduced quality of field produce

When the crop is harvested from a weedy field the seeds of weeds get mixed with the main crop which results in lowering the quality of the produce e.g., seeds of weeds in wheat, gram, etc. Weeds harbour insect, pests and diseases. The irrigation efficiency is also reduced. Weed secretions are harmful. Heavy growth of certain weeds like quack grass or *motha* lower the germination and reduce the growth of many crop plants. This is said to be due to the presence of certain phytotoxins in these weeds. Weeds are harmful to human beings. Certain weeds cause irritation of skin, allergy and poisoning in human beings. Weeds cause quicker wear and tear of farm implements; they get worn out early and cannot work efficiently unless they are properly sharpened or mended. Weeds reduce the value of the land. Agricultural lands which are heavily infested with perennial weeds like kans always fetch less price, because such lands can not be brought under cultivation without incurring heavy expenditure on labour and machinery.

Weeds can compete with productive crops or pasture or convert productive land into unusable scrub. Weeds are also often poisonous, distasteful, produce burrs, thorns or other damaging body parts or otherwise interfere with the use and management of desirable plants by contaminating harvests or excluding livestock. They provide competition for space, nutrients, water and light. Mechanical methods of weed control are simple and easily understood by farmers. The tools and implements for mechanical weed control are mostly manual and animal operated. Manual method is most effective but is slow. It is popular in regions where labour wages are low and labour is easily available during the season. The additional cost of weeding using implements is comparatively less than the gains due to extra yields obtained. First weeding operation is mostly done between and along the rows. Remaining operations are done mostly between the rows. Spades or weeding choppers work on the principle of impact and have straight, curved or pronged blades. Weeds are removed by digging, cutting and uprooting. These are operated in the bending posture. The operation is normally slow and tiring. In oilseed crops, intercultural and weeding operations could be done quickly and efficiently by using improved animal drawn implements. It is essential to provide wider row spacing (above 30 cm), for movement of animals and implement, if animal drawn weeders are to be used. Accurate row spacing and straight rows are a must for successful weeding. Animal drawn tools reduce the cost of operation and time. With increasing row crop cultivation at various

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row widths, it often becomes necessary to use different sizes and shapes of blades to intercultivate growing crops. The implements for intercultivation can therefore be designed with quick attaching working parts like exchangeable blades to make them versatile.

For mechanical weeding, few equipments are developed and commercialized which may be suitable for north eastern region. The equipments developed by ICAR which can control weeds mechanically based on different power sources, may play effective role in weed management are following:

Cono Weeder

The cono weeder is used to remove weeds between rows of paddy crop. The weeder consists of two rotors, float, frame and handle. The rotors are cone frustum in shape, smooth and serrated strips are welded on the surface along its length. The rotors are mounted in tandem with opposite orientation. The orientation of rotors creates a back and forth movement in the top 30 mm of soil. The float, rotors and handle are joined to the frame. The float controls working depth and does not allow rotor assembly to sink in the puddle. The push-pull operation of cono weeder in between rows makes weeding effective. It costs Rs. 1900 and field capacity is 0.18 ha day^{-1}.

Wheel Hoe

It is a manually operated long handle push-pull type tool and widely used for weeding and interculture in row crops. The number of wheels varies from one to two and the diameter depends upon the design. The frame has got a provision to accommodate different types of soil working tools such as straight blades, reversible blades, sweeps, V-blade, tine cultivator, miniature furrower, spike harrow (rake) etc. The handle assembly has a provision to adjust the height of the handle to suit the operator. For operation, the working depth of the tool and handle height are adjusted. It covers 0.10 ha day^{-1}. It costs Rs. 800 and cost of operation is Rs. 2000 ha^{-1}.

SRI power weeder

It is suitable for timely weeding operation under all soil conditions in line sown paddy and SRI paddy. It has two weeding blades and powered by 1.3 kW engine having weight of 17 kg. The working width of the weeder is 150 mm. The unit cost and cost of operation are Rs. 40,000 and Rs. 1100 ha^{-1}, respectively. It saves 74% in cost of operation as compared to manual weeding.

Tractor operated auger plough for green manuring and straw incorporation

The green manuring and straw incorporation involve high labour and cost in traditional practice. The green manure and straw need to be cut effectively and incorporated in single pass for well preparation seedbed. To address the problem of incorporation of green manure and straw a tractor operated two bottom auger which is actually a combination of cutting unit, truncated/shortened mould board and vertical rotating clod-crusher/soil-ripper. The cutting unit cuts the crop mass into small pieces. The share of MB plough cuts the furrow slice and the shortened mould board lifts it. Finally, the vertical rotating auger behind each bottom pulverizes the furrow slice and buries the crop biomass.The effective field capacity and fuel consumption of auger plough are 0.25-0.28 ha h^{-1} (at forward speed of 3.5 km h^{-1}) and 6.68-8.22 l h^{-1}, respectively

Tractor operated intra row cum inter row weeder for orchards

A low hp tractor operated intra row cum inter row weeder consists of gear box with a pair of bevel gears, hydraulic pump, hydraulic oil reservoir (capacity

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15 l), single acting cylinder, double acting cylinder, hydraulic valve assembly with a pair of inlet and outlet hose pipes, hydro-mechanically controlled sensor, hydraulic relief valve actuator, rotary unit (width 520 mm) consisting of 18 nos. of C-shaped blades, three point linkage with provision of two skids at the bottom etc. The overall dimensions of the machine are 1070 x 700 x 800 mm. It is easy to extend and retract the rotary unit by swiveling action of hydro-mechanically controlled sensor. Hence, there is no need of ultra light sensor based movement of the arm. In the weeder, wrap around frame ensures upfront visibility to the operator. Mechanical linkages with hydraulic mechanism have been used to reduce cost of the machine. The effective field capacity of the machine is 0.15-0.17 ha h^{-1}. The weeding efficiency of the machine is 95%. There is net saving of Rs. 1775 ha^{-1} in pomegranate orchard and Rs. 1480 ha^{-1} in grape vineyard over traditional method.

Tractor Mounted 3-Row Rotary Weeder

It consists of a main frame, gearbox, three rotary weeding blade assemblies, a 40 mm square shaft for transmission of power from gearbox to rotary assemblies and a set of sprockets and chains. A standard 3-point hitch arrangement has been provided to mount the frame to tractor. Power from tractor PTO is transmitted to main square shaft through gearbox mounted on main frame and a set of sprockets and chain. It facilitates adjustment of row-to-row spacing from 675 to 1165 mm. The effective field capacity of machine is 0.24 ha h^{-1} with weeding efficiency of 83-87%. The approximate cost of this machine is Rs. 60,000. The cost of operation with the machine is Rs. 1700 ha^{-1} for single weeding as compared to Rs. 3600 ha^{-1} by manual weeding. The machine saves 54% labour and 74% cost of operation as compared to traditional method.

Fertilizer Band Placement cum Earthing up Machine

The tractor operated (26 kW and above) fertilizer band placement cum earthing up is suitable for simultaneous placement of fertilizer, earthing up and cutting of weeds in crops such as maize, sugarcane, potato etc having more than 0.50 m row to row spacing. The urea fertilizer application rate ranges from 60 to 250 kg ha^{-1}. It helps in top dressing of fertilizer at 50 to 100 mm from the plant. The effective field capacity of machine is 0.56 ha h^{-1} with 82.4% field efficiency. The approximate cost of the machine is Rs. 50,000. There is considerable saving in fertilizer, time and labour over traditional method.

Self-propelled Power Weeder

The machine is useful in row crops and horticultural crops for weeding and seedbed preparation. It consists of a 4.1 kW diesel engine mounted on the power tiller chassis, power transmission system, two MS wheels, a frame and a rotary tiller. The speed of power weeder ranges 2.3-2.5 km h^{-1} with an effective working width of 550 mm giving effective field capacity of 0.10 to 0.13 ha h^{-1}. The cost of self-propelled power weeder is about Rs. 40,000 and average cost of weeding is Rs. 1000 ha^{-1}. The equipment saves 90% operating time and 30% in cost of weeding as compared to hand weeding by *khurpi*.

Tractor operated rotary slasher for weeds cutting

It is powerful enough to cope up with tall weeds due to use of reversible steel blades The commercial units are available of 1900-2500 mm in length and 1800-2500 mm in width. Such units can provide working width of 1750-2350 mm. The height adjustment can be done from 25 to 200 mm. It is provided with safety chain shield standards. The cost effective weeding cutting equipment can provide effective field capacity of 0.30 ha h^{-1} and cost of operation is Rs. 2000 ha^{-1} as compared to Rs. 75000 ha^{-1}.

Conclusion

In the North East Region, the farmers can save Rs. 4800 ha^{-1} if manual hand weeders are used ensuring 70% in time of weeding. Similarly, self-propelled SRI weeder and power weeder can be beneficial if promoted in whole North East Region due to its cost effectiveness by 60-70%, time saving of 90-93% and being lighter in weight these can be suitable. The unit price may be Rs. 0.50 lakh - Rs. 0.70 lakh and operational cost varies Rs. 1200-1600 ha^{-1}.

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NEED FOR DEVELOPMENT OF MARKET OF FRESH FRUITS AND VEGETABLES IN NE REGION

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For any commercial enterprise, the products are to be marketed properly, safely and beneficially otherwise all the investments, inputs, hard work become useless. Hence every commodity that is produced should reach the consumer and marketing is all about how the commodity reaches the consumer. There is no profit of producing any commodity if it does not reach the consumer from market. Market is a place where goods/commodity are bought and sold. Northeast Region of India has an excellent market potential and higher profit margin on fruit and vegetable based products. Varied horticultural crops are produced in northeastern region like banana, citrus, pineapple, cashewnut, jackfruit, coconut, tea, rubber, guava, papaya with a variety of vegetables. Tripura receives geographical indication for Queen Pineapple, Meghalaya for *Khasi* Mandarin and Manipur for *Kachai* Lemon while the revenue earned from this sector is meagre due to lack of processing and marketing. The total spice production is 5.5% of national production; pineapple production is 46.49% of national production. But most of the produce go to waste during the production due to lack of processing and storage facilities and inadequate infrastructural facilities. This implies the immediate need of transporting these produce to the consumer either for immediate consumption or for processing purpose depending upon the need of the consumer.

All the commodities are not grown at all places so marketing is done to distribute at long distance but the marketing of fresh fruits and vegetables is complex and risky since they are highly perishable so they get spoilt and damaged easily. Therefore, they require low temperature and high humidity during handling, storage and distribution along with good packaging.

Marketing channels between growers and consumers

Marketing channel is the route through which a commodity moves from the producer to the consumer. The more the number of middle man, the lesser would be the producer's rupee. In banana marketing the producer's share in consumer's rupee is around 31-35%. There are a number of marketing channels:

a. Producer → Consumer
b. Producer → Retailer → Consumer
c. Producer → Wholesaler → Retailer → Consumer
d. Producer → Agent → Retailer → Consumer
e. Producer→Agent→wholesaler→Retailer →Consumer
f. Producer → Forwarding Agent → Commission Agent → Wholesaler → Retailer → Consumer
g. Producer → Producer's Cooperative → Wholesaler → Retailer → consumer
h. Producer → Preharvest Contractor → Commision agent → Wholesaler → Retailer → Consumer
i. Producer → Commission agent → Wholesaler →Retailer → Consumer
j. Producer → HPMC →Wholesaler → Retailer → Consumer
k. Producer → Processing unit → Commission Agent →Wholesaler → Retailer → Consumer

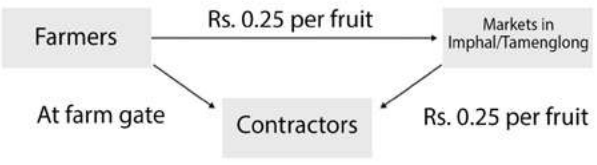

Fig. 1 Marketing channel of *Khasi* Mandarin in Manipur

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Transportation

Transportation is very important for moving the produce from the producer's end to the market and then to the consumer. Favourable means of transport for fresh fruits and vegetables may be done through the followings:

A. Non Refrigerated Trucks: This is a very prompt transportation system and generally used commonly for transportation upto 500 km.

Advantage: Trucks are independent and can move long distances as soon as truck is filled. Unlike rail and ships, it can reach different places within the cities.

Disadvantage: More impact and bruishing injury occurs to the fruit due to undulated roads and jerks experienced during the journey. More damage is caused during hot summers and rainy season to the fruits.

B. Rail: It is also a common type of transportation used for many crops used for transportation of long distance (more than 1000 km)

Advantages: Less jerks and bruishing to the fruits and transportation can be faster than trucks

Disadvantage: All places within a city cannot be reached especially in hilly region and movement depends on clearance of route and schedule of trains.

C. Jeep/Camper: This is mainly for very near destination market (30-50 km) to the production centre.

Advantage: Transport can be done even in the narrowest of roads where trucks can not enter. Since cost is less, small growers can easily hire for transportation and transportation can be faster than trucks

Disadvantage: Not suitable for long distance transportation.

D. Ships: These are used to very less extent in India. This is used mainly for transport to international markets.

Advantage: It can carry very huge weights and causes lesser postharvest losses

Disadvantage: Slow means of transportation and it is not suitable for highly perishable produce

E. Air transport: This mode of transport is common only for exports and to remote inaccessible areas within the country during natural calamities.

Advantage: Very fast means of transport with better shelf life of produce.

Disadvantage: Costly and unfordable to common grower in India and not available at all places. It cannot reach every small place.

Export of Fresh and Processed Fruits and Vegetables

There are several export promotion agencies working at National and State levels for increasing exports of various commodities (fresh as well as processed from India). Out of these two important agencies activities are discussed below:

1. APEDA Agricultural and Processed Food Products Export Development Authority:

This was established by the Government of India under the Agricultural and Processed Food Products Export Development Authority Act passed by the Parliament in December, 1985.

Functions of APEDA

- Development of industries for export by way of providing financial assistance.
- Registration of persons as exporters.
- Fixing of standards and specifications for the purpose of exports.
- Carrying out inspection of meat and meat products in slughter house, processing plants, storage premises, ensuring the quality of such products.
- Improving packaging and marketing of products outside India.
- Promotion of export oriented production and development of products.
- Collection of statistic from owners of factories.
- Training in various aspects of the industries.

Products Monitored by APEDA: Fruits, vegetables and their products, meat and meat products, poultry and poultry products, dairy products, confectionery, biscuits and bakery products, cocoa and its products, chocolates of all kinds, alcoholic and non alcoholic beverages, cereal, cereal products, groundnuts, peanuts and walnuts, pickle, papads and chutney, guar gum, floriculture and floricultural products, herbal and medicinal plants, rice (non-basmati).

2. NERAMAC (North Eastern Regional Agricultural Marketing Cooperation Limited):

This was established to support farmers of North East to get remunerative prices for their produce and thereby

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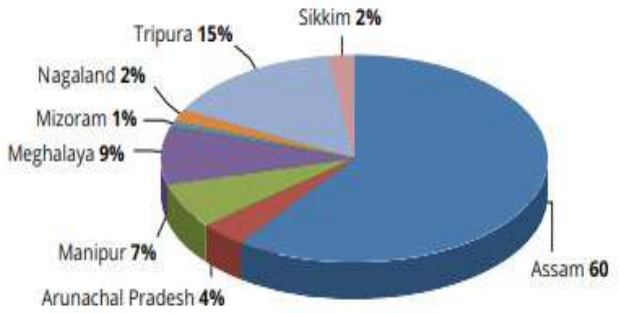
bridge the gap between the farmers and the market as well as to enhance the agricultural, procurement, processing and marketing infrastructure of the North Eastern Region of India.

Functions of NERAMAC

- To bring development and marketing of horticultural products within and outside the North Eastern Region and supply of inputs, tools, equipment etc. which are required for development of horticulture and agro-based industries which may be run by Government, statutory body, company, firm, co-operative or individual.
- Undertaking, establishing, acquiring, purchasing, selling and managing projects for development of horticultural products and perform the distribution of seed, plants, processed food and other products connected with the development of horticultural products.
- Management, promotion and expedition of export of raw and finished horticultural produce and equipment and also to import raw and finished horticultural produce and equipment.

Products Monitored by NERAMAC: They exported true Potato Seeds (TPS) produced in the sponsored projects at Nagichera, Tripura to Bangladesh, Indonesia, Nepal, Mexico and South Korea. Pineapple pulp has been marketed to Hindustan Uniliver Ltd., while frozen pineapple juice concentrate and litchi pulp from the North Eastern Region are supplied to M/s Dabur Foods, Nepal. Processed cashew nut from different processing units in Mankachar district of Assam and Phulbari region of Meghalaya. It is responsible for marketing different agro-horticultural produce like ginger, Bird's Eye Chillies, maize, black pepper, raw cashew nut, pineapple, supari etc. outside the region to help the farmers in getting economic returns. The main aim is to create marketing structure for processed products and fresh fruits and vegetables of North East Region.



Source: ISAP Analysis & NHB Data, 2011

Fig. 2 Statewise contribution to horticulture in North East Region of India

Fig. 3 Traditional market in Imphal, Manipur

Fig. 4 Non Regulated market in Shillong

Conclusion

Though North Eastern Region the farmers are not receiving good returns due to failure in marketing. Entire produce is not sold at market level and markets lack in basic facilities like cold storage facility. Due to poor market and perishability of commodities, the farmers sell their produce at a throwaway prices to the middlemen without even getting the opportunity to display them in the open market. In most states, either there is no regulated market or most of the trade is practised in non regulated/traditional markets. Due to lack of organised marketing structure in the North East Region, farmers are getting low return compared to other parts of India while the middlemen get the profit at their expense. Rural markets are preferred by the farmers due to proximity to production center and less transportation cost. Government should intervene to reduce the loss of the farmers who already made good production and help the farmer to increase their return as well as development of the region.

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SUSTAINABLE AGRICULTURAL DEVELOPMENT THROUGH ACCELERATING THE FARM MECHANIZATION IN NORTH EASTERN REGION

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The basic users of draught animal power are generally small, marginal and medium holding size farmers. There are 84.97% of operational holdings in marginal and small holding category which depends fully on animal power for farm operations. Further where the land holdings size of farmers is less than 2 ha, it would be well managed by one pair of bullocks. Organic farming is coming up in a big way in the country. At present about 90% of the registered farmers adopting organic farming has been from small and marginal farmers having up to 2 ha holdings. These farmers are also the major users of animal energy for cultivation purposes. Therefore, there is a need to develop matching implement for mechanized organic farming. For small farms, the animal-human system is the best fit for practicing resource conservation, organic and integrated farming system. It gives higher economic value to the farmers by means of quality green/organic produce without damaging the soil and environment. Draught animal system is in perfect harmony with the village ecosystem. Animal energy is environmental friendly which saves about Rs. 60,000 crores worth of fossil fuel annually. They are fed by crop-residue and produce manure. Draught animals produce 40 billion tonnes of dung, which are used to make farmyard manure, compost and vermi-compost and enhance the productivity of soil. There is a huge potential for developing products from cattle dung and urine.

The hilly region of country is largely located in the Himalayas extending up to 2500 km in length and 250 to 400 km in breadth. Longitudinally, Himalayas are also classified as Shivaliks flat summits, middle Himalayas, greater Himalayas and trans Himalayas. In India, the mountain ecosystem is spread over 12 states of India: Jammu & Kashmir, Himachal Pradesh, Uttaranchal, Sikkim, Assam, Arunachal Pradesh, Mainipur, Meghalaya, Mizoram, Nagaland, Tripura and West Bengal. They are inhabited by 51 million people, covering 18% of the geographical area and 6% of India's population. In fields (hilly terrain, terraced cultivation, coastal, wet fields and desert lands) where tractor or self-propelled machinery cannot reach, animals are used for field preparation, puddling, sowing and transportation. In hilly areas, animals can assist with contour ploughing and terracing also.

Draught animals play an important part in organic farming also and supplies dung, a source of renewable energy in farm of biogas. Thus, draught animal system is more oriented towards organic farming. Animal power still has relevance for the mechanization of small farms. The status of area per animal of working animals is given in Table 1. The Mizoram has lowest strength (7045) of draught animals and maximum draughts animals (250778) are in Arunachal Pradesh as given in Table 1. Landholdings pattern indicates maximum (2720000) in Assam followed by Tripura (578479) as mentioned in Table 2. The maximum area under small land holdings was 687000 ha in Assam followed by 77000 ha in Meghalaya as given in Table 3. Under total operational land holdings, maximum area (2999000 ha) was in Assam followed by 1074000 ha in Nagaland (Table 3). Average size of operational holding in hilly regions was maximum (6.02 ha) in Nagaland and minimum (0.49 ha) in Tripura as mentioned in Table 4. State-wise women operational holdings in hilly regions were maximum (73000) in Meghalaya and Minimum (3000 no.) in Sikkim as given in Table 5. The tribals operational holdings in hilly regions were maximum (438000) followed by Meghalaya (209000) and minimum (37000) were in Sikkim as shown in Table 6.

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Table 1 Draught animals and available area in ha per animal power in NEH Region

State	Draught Animals	ha/ animal power
Arunachal Pradesh	250778	1.31
Manipur	63441	4.41
Meghalaya	114540	4.02
Mizoram	7045	26.69
Nagaland	61298	0.98
Sikkim	25025	7.59
Tripura	173527	3.23

Table 2 Land holding pattern in NEH Region

State	Marginal	Small	Semi-medium	Medium	Large	Total
Arunachal Pradesh	2146	19333	34038	27941	6530	109298
Meghalaya	102714	57755	40542	8312	238	209561
Manipur	76735	48850	22235	2760	40	150620
Nagaland	6476	20338	48457	77968	22172	178411
Mizoram	50210	29753	9922	1731	264	91880
Sikkim	40476	16941	10809	5922	780	74928
Tripura	499054	55043	21544	2752	86	578479
Assam	1831000	497000	304000	85000	4000	2720000

Table 3 Statewise and category wise area of operational holdings in NEH Regions (000, ha)

State	Marginal	Small	Semi-medium	Medium	Large	Total
Arunachal Pradesh	12	26	94	155	97	384
Meghalaya	46	77	113	47	4	287
Manipur	40	63	55	13	Neg.	172
Nagaland	3	23	125	481	442	1074
Mizoram	30	38	24	9	4	105
Sikkim	15	20	27	32	12	107
Tripura	14	6	4	1	Neg.	25
Assam	775	687	818	437	282	2999

Table 4 Average size of operational holding in NEH Regions (in ha)

State	Marginal	Small	Semi-medium	Medium	Large	Average land holding
Arunachal Pradesh	0.55	1.34	2.76	5.54	14.9	3.51
Meghalaya	0.45	0.33	2.79	5.67	16.48	1.37
Manipur	0.52	1.28	2.48	4.86	11.00	1.14
Nagaland	0.51	1.13	2.58	6.17	17.57	6.02
Mizoram	0.60	1.27	2.42	5.13	15.09	1.14

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Sikkim	0.37	1.20	2.49	5.44	15.77	1.42
Tripura	0.28	1.38	2.52	5.07	14.29	0.49
Assam	0.42	1.38	2.69	5.15	68.11	1.10

Table 5 State-wise women operational holding in NEH Regions (in ha)

State	Marginal	Small	Semi-medium	Medium	Large	Average land holding
Arunachal Pradesh	4000	2000	3000	2000	1000	11000
Meghalaya	36000	19000	15000	3000	Neg.	73000
Manipur	3000	1000	1000	Neg.	Neg.	5000
Nagaland	1000	3000	5000	7000	2000	18000
Mizoram	6000	3000	1000	Neg.	Neg.	10000
Sikkim	2000	1000	Neg.	Neg.	Neg.	3000
Tripura	54000	5000	2000	Neg.	Neg.	61000
Assam	32000	15000	9000	2000	Neg.	58000

Table 6 Status of number and area of tribals operational holdings in NEH Region

State	Number of operational holdings	Area of operational holdings (ha)
Arunachal Pradesh	107000	380000
Meghalaya	209000	286000
Manipur	64000	79000
Nagaland	178000	1072000
Mizoram	92000	105000
Sikkim	37000	57000
Tripura	163000	124000
Assam	438000	517000

Important Equipment

Few equipment for plains of North Eastern Region may play effective role for faster mechanization and comforts to operator of equipment which are mentioned below:

Tractor Operated Check Basin Former (MPKV)

It is suitable for forming check basins of 2 x 6 m size. The equipment scrapes, collects and distributes the collected soil uniformly to form side bunds and cross bunds at regular interval of 6 m in a single pass. It gives 96% saving in time and 32% in cost of operation as compared to conventional manual method. The investment on purchase (Rs. 70,000) of machine can be recovered by forming check basins in 71 ha area using this equipment. The implement has been commercialized and available with M/s Bhansali Agricultural Implements Pvt. Ltd., Kopargaon District.

Self-Propelled Power Weeder (SRI)

The fields need to be planted by SRI method in check row (225 x 225 mm) pattern. Farmers can be able to cover four times more area in weeding with the use of SRI power weeder which can help them in maintaining timeliness of weeding operation. The farmers feel

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comfort in using SRI power weeder and relieve from undue fatigue in half bending posture in manual weeding of rice crop under standing water condition.

It is a self-propelled, compact and light weight power weeder. It weighs 17 kg and consists of 1.30 kW engine, float and rotary cutting blades. There are four high speed rotating blades (300 rpm) on either side, which weed two rows at a time. The weeding width is 150 mm. It is easily maneuverable between the crop rows at speed due to compactness and less weight. The average forward speed of operation of power weeder is about 30 m min^{-1} as compared to 15 m min^{-1} with cono-weeder. The average fuel consumption is 0.40-0.65 l ha^{-1}. The machine weeding saves Rs. 6530 ha^{-1} in two passes as compared to conventional manual method. Thus the farmer can recover the capital investment (Rs. 40000) for purchase of unit by using it in total 6.12 ha or using it for 70 h only under SRI method. It attributes minimum increase in yield of 8% in SRI cultivation system of rice. It is commercially available and can be procured from M/s Premier Power Equipments Ltd., Coimbatore.

Tractor Operated Flail Type Harvester-Cum-Chopper-Cum-Loader (PAU Design)

The crops *viz.* bajra, sorghum, maize, berseem and oats with height 1.00 to 2.50 m and stalk density of 20-80 plants m^2 can be harvested successfully by fodder harvester with loading arrangement. The traditional harvesting of fodder is performed in 120-150 man-h ha^{-1} and filling in trailer take extra time but such machine performs both tasks in 5 h only. There is a saving in cost of operation by 75% as compared to traditional practice. The machine consists of a rotary shaft mounted with blades (flails) to harvest the crop, auger for conveying the cut crop, cutters for chopping and conveying chopped fodder through outlet into the trailer. The blades on the rotary shaft are staggered

in three rows of 13 blades each on a horizontal axis perpendicular to the direction of motion. The blades cut the crop and auger conveys it to the chopper unit. The chopping mechanism having 4 blades cuts crops into pieces and the chopped material is thrown out at high speed and is filled into the hitched trailer to the machine. It also harvested lodged and over matured crop without any difficulty. The cost of operation of the machine is Rs. 1500 ha^{-1} against Rs. 3200 ha^{-1} by conventional method. The investment on purchase of machine can be recovered by harvesting fodder in total 58.8 ha area. The machine cost is Rs. 1 lakh and size of cut fodder is 89 mm.

Brush Cutter With Fruit Holding Attachment For Pineapple Harvesting

Traditionally pineapple is harvested manually using a special knife. Also some of the leaves of pineapple plant are pruned prior to detach the fruit from the plant as a pre-harvest operation in Kerala region to overcome such problems, improved unit for harvest of pineapple has been developed for comfort of operator. This consists of brush cutter with backpack type engine and

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manual fixed holder (weight 1.3 kg) with movable base plate (150 mm size). The distance between the blade and holder was adjustable. The weight of brush cutter with attachment was 4.85 kg. The range of movable distance between the blade and holder was 30 mm. The height between the base plate of holder and blade was 25 mm. The speed of blade and fuel consumption of unit were 6500 rpm and 1.1 l h^{-1}, respectively. The average time for harvesting 10 fruits was 4 min. Maximum diameter of fruit which can be harvested was 140 mm. It helped in reducing human drudgery and required less time for harvesting Kew variety of pineapple. The performance was better than pineapple harvesting unit with gripping fingers in which the fruit was gripped while harvesting and had difficulty in handling during operation.

Self-propelled Fodder Harvester (Cutter Bar Type):

The self-propelled cutter bar type (CBT) forage harvesters are in extensive use for forage harvesting. The cutter bar is operated by a suitable engine (7.6 kW, air cooled). The cutter bar is fitted as an attachment to the reaper-binder machine. The machine is used for harvesting fodder crops like berseem and lucerne. The width of cut is 1.2 m and height of cut is 50-100 mm for berseem crop. The effective field capacity of the harvester is 0.4 ha h^{-1} at forward speed of 4.00 km h^{-1}.

Power Tiller Operated Vertical Conveyor Reaper:

It is a power tiller front mounted, walk behind type reaper wind-rower suitable for harvesting and windrowing of erect rice crop. The reaping attachment consists of cutter bar, two crop conveyor belts, crop row dividers and star wheels. The cutter bar and conveyor belts are driven by engine through belt-pulley and safety clutch. The effective field capacity is 0.16-0.20 ha h^{-1}. The unit price is Rs. 40,000 and its cost of operation is Rs. 1400 ha^{-1}.

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BIOFLOC TECHNOLOGY IN CULTIVATION OF GIANT FRESHWATER PRAWN, *MACROBRACHIUM ROSENBERGII* USING DIFFERENT CARBOHUYDRATE SOURCES IN NE REGION

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The biofloc technology is based upon zero or minimal water exchange to maximize biosecurity while minimizing external environmental effects. Using artificial aeration to meet oxygen demand and suspend organic particles, the development of a heterotrophic microbial community is encouraged in the pond. This diverse microbial community functions to mineralize wastes, improve protein utilization and reduce opportunities for dominance of pathogenic strains. Freshwater prawns are preferred among the farmers due to high price in the market. Research works revealed that Giant freshwater prawn (*Macrobrachium rosenbergii*) was able to take up bioflocs as an additional protein source. Several studies have pointed out the importance of using less expensive energy sources such as lipids and carbohydrate in order to save costly protein. Optimal level of protein and the protein-sparing effect of non-protein nutrients such as lipids or carbohydrates may be effective in reducing feed costs.

Technology

Biofloc aquaculture is a sustainable solution for the development of aquaculture and this technology is fully based on the concept of carbon nitrogen (C/N) ratio. The control of inorganic nitrogen accumulation in the pond is based upon carbon metabolism and nitrogen immobilization into microbial cells. Bacterial cells are composed of proteins. Carbon nitrogen ratio of most microbial cell where inorganic nitrogen accumulation is controlled through the addition of carbonaceous substrates, raising the C/N ratio and leading to the immobilization of nitrogen through the production of microbial proteins.

Basic Principle

The basic principle of the activated suspension technique and the C/N ratio controlled systems were recently referred as biofloc technology (BFT) as it is the retention of waste and its conversion to biofloc as a natural food within the culture system. Biofloc technology (BFT) is an innovative technology identified for solving the hurdles in scampi (Giant freshwater prawn) farming disease outbreak like MHPV, MMV WSVB, poor survivability and growth as well as environmental degradation problems. One of the features of natural aquatic environment is the ability to recycle the nutrients. Accumulation of toxic inorganic nitrogen species (NH_4^+ and NO_2^-) is prevented in biofloc system by maintaining a high C/N ratio and inducing the uptake of ammonium by the microbial community.

Experiment

Initiative was taken to estimate the efficiency of different carbohydrates sources as induced biofloc system in scampi culture and to compare the production of Giant freshwater prawn in BFT applied and normal culture systems. The cultivation was carried out in fifteen FRP tanks with 1200 l capacity and with an effective bottom area of 1.25 m^2 rearing system for 120 days at College of Fisheries, CAU, Lembucherra, Tripura. All tanks were filled with supplied water maintaining a depth of 60 cm. Tanks were provided with air-stone hoses type of diffuser system for 24 hours aeration throughout the culture period for increasing biofloculation rate and keeping one week for dechlorination. Lime was then added for fertilization at a dosage of 4 g m^2. Urea and super phosphate were added as fertilizers at a mild dosage of 4 and 1 g m^2 $week^{-1}$respectively during the first three weeks. Pelletized sinking feed were provided and different carbohydrates sources were used as induced biofloc.

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Fig. 1 Experimental biofloc tanks for prawn farming

Fig. 2 Plastic made shelter for prawn

Treatment

Five treatment tanks with triplicate were used. In all the 3 sets of replicates juvenile prawns @15 m^2 were stocked. Other than control T1, 4(four) types of locally available bio-flocculating agent (Maize T2, Taro T3, Sweet potato T4 and Jackfruit seed T5) were used in different treatment to access the suitability.

Preparation of Carbohydrate Sources and Feed

Locally available carbohydrate sources Maize (*Zea mays*), Taro (*Colocasia esculenta*), Sweet potato (*Ipomoea batatas*) and Jackfruit seed (*Artocarpus heterophyllus*) were used as carbohydrate sources for bioflocculation. Raw tubers like Taro; Sweet potato and Jackfruit seeds were peeled and washed thoroughly, made into small pieces and soaked in water overnight. Maize kernel were removed from the cob and cleaned properly. All the four carbohydrate sources were kept in oven at 60°C till it dried completely. The dried ingredients were then powdered in a mixer grinder and the powder was stored in air-tight container and used for prepation of feed (Table 1).

Table 1 Ingredients of pelleted feed in composition

Ingredients	Composition (%)	Crude Protein (%)
Rice bran	30	20
Mustard oil cake	15	
Wheat bran	30	
Fish meal	15	
Corn meal	10	

Assuming that the C: N ratio will be maintained at the value of 10 and the added carbohydrates contain minimum of 50% carbon, the amount of different carbohydrates was needed as follows:

Experimental Feed Protein (g kg^{-1})	Carbohydrate required for biofloculation (g kg^{-1} of feed)	C: N ratio
200	322	10

Preparation Of Microbial Floc

The amount of organic supplementation was calculated based on the standard method assuming that 6 g of carbon is needed to convert 1g of TAN (Total Ammonia Nitrogen) generated from feed into bacterial biomass. The basic process of microbial ammonium immobilization was demonstrated in a laboratory experiment where pond sediment suspension was enriched with ammonium salt. Addition to that 20 g samples of pond clay soil collected from pond were aerated for 24 h with 1 litre of tap water enriched with $(NH_4)_2SO_4$ at an initial concentration of about 10 mg l^{-1} and 200 mg l^{-1} glucose. With this estimation, 30 litres of tap water were collected in empty glass aquarium where aeration were supply efficiently for 24 hours.

Fig. 3 Vigorous aeration of BFT treatment tank

Fig. 4 Measurement of biofloc with Imhoff cone

Feeding and Water Management

Juvenile prawns were fed with crumble sinking pelleted feed (Table 2) having protein content of 20% which was prepared from the feed ingredients, *viz*., rice bran, mustard oil cake, wheat bran, fish meal and corn meal maintaining appropriate inclusion level. The prawns were fed with pelleted feed at 10% of initial weight (1-30 days) and adjusted gradually to 8% for period of 30-60 days and decreasing to 5% for periods of 60-90 days and 3% body weight at the end of the culture (90-120 days).

Table 2 Composition of erumble sinking pelleted feed

Compo-sition	Moisture (%)	Protein (%)	Lipid (%)	Ash (%)	Fibre (%)	NFE (%)
Pelleted feed	9.0	20.0	6.0	11.0	12.5	41.5

After inoculation of biofloc mother stock, time to time further addition of biofloc liquid is carried out based on periodic estimation of biofloc. Vigorous and continuous aeration for bio-floculation is also provided. Sampling of prawn is done periodically for growth and survival estimation. Water quality is also maintained and estimated periodically.

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Results/ Outcome

Significantly higher ($p<0.05$) weight gain (g) was fund in all the biofloc treatment tanks as compared to control (without biofloc) where highest in T4 (20.24±1.58) where sweet potato was used as biofloculating agents followed by T2 (19.07±1.00) where maize was used as bio-flocculating agents.

Individual growth of prawn was highest in T4 (sweet potato) where 63.82% additional growth was obtained followed by T2 (maize) 53.18%; T5 (Jackfruit seed) 43.36% and T3 (Taro) 27.64% respectively as compared to T1 (Control).

Net yield (g) of prawn was found significantly higher ($p<0.05$) in T4 (341.64±5.05) with sweet potato followed by T2 (321.79±29.4) where maize was used as biofloculating agents as compared to without carbohydrate source added. Percentage wise higher net yield was obtained in all biofloc treatments where 26.29 % in T4, 21.92% in T2, 19.16% in T5 and 7.86 % in T3 additional net yield was found in different carbohydrate based biofloc systems as compared to control.

Survival rate of prawn in all the biofloc treatment tanks were found to be higher than control but without significant difference ($p<0.05$) among the treatment. The highest survival rate was observed in T3 (75.00±5.00) where Taro was used as carbohydrate for bio-floculating agents followed by T2 (73.33±2.88) and T4 (73.33±2.88) where maize and sweet potato was used as a bio-floculating agents. The lowest survival rate was obtained in T1 (70.00±5.00) in control treatment tanks followed by T5 (71.66±2.88) where jackfruit seed was used as a carbohydrate source for bio-floculating agent.

Feed conversion ratio of prawn was found to be significantly lower ($p<0.05$) in T5 (2.99±0.18) where jackfruit seed was used as carbohydrate source for bio-floculating agent and T4 (3.03±0.07) where sweet potato was used as carbohydrate source for biofloculating agent than that of the control T1 (3.64±0.35) and T2 (3.50±0.50) where maize was used as carbohydrate source for bio-floculating agent.

The total heterotrophic bacterial counts were found higher in all the biofloc treatment tanks as compared to control resulted in the utilization of oxygen for microbial metabolism as bacteria utilized the added carbohydrates as food and synthesized microbial protein.

Water quality parameters (physical, chemical and biological) that also affect the growth and welfare of cultured organisms. During the study period the temperature ranged from 17.42-17.86^{0}C, dissolved oxygen ranged from 8.72-10.06 mg l^{-1}, pH (water and sediment) ranged from 7.56-7.96, total alkalinity ranged from 41.17-69.51 mg l^{-1}, free carbon dioxide ranged from 1.98-2.09 mg l^{-1}, nitrite-nitrogen ranged from 0.367-0.0797 mg l^{-1}, ammonium-nitrogen ranged from 0.093-0.300 mg l^{-1}, nitrate-nitrogen ranged from 0.24-2.34 mg l^{-1}, and primary productivity ranged from 0.18-2.71 mg C m^{-3} hr^{-1} .

Fig.5 Giant FW prawn cultivated in biofloc system

Fig. 6 Agar medium for total heterotrophic bacterial count

Conclusion

The experiment revealed that freshwater prawn in biofloc system exhibited positive results in growth along with individual performance, total production yield, and well being. Survival of prawn was higher in all the biofloc treatment (71-75%) but it was noticed higher in biofloc treatments. Among the carbohydrate sources, highest growth rate of prawn was observed where sweet potato was used followed by maize; jackfruit seed and taro. Sweet potato showed the highest growth among all the treatments as 40-90% of total sugar was in the form of sucrose which is found to be suitable source of dietary carbohydrate for prawns. The study also showed the scope of use of locally available low cost carbohydrate sources in partial replacement of high cost protein based feed through formation of microbial protein. Hence, adoption of Biofloc technology (BFT) in freshwater prawn farming may be encouraged in this part of the world. In this technology, enhancement of production and productivity by replacement of the existing aquaculture system with partially reducing the recommended protein feed as well as addition of locally available low cost carbohydrate materials as a source of microbial protein will be a better option.

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ZERO TILLAGE CULTIVATION UNDER RICE FALLOW LAND

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Conventional tillage involves primary tillage to break open and turn the soil followed by secondary tillage to obtain seed bed for sowing or planting. Continuous use of heavy plough create hard pan in the subsoil, results in poor infiltration. It is more susceptible to run-off and erosion. It is capital intensive and increase soil degradation. To avoid these ill effects and push to make farming more sustainable, an increasing number of conservation-minded farmers have turned to what is called **no-till agriculture (Zero tillage).** No-till approach started from 1960s by farmers in India. The zero-tillage system is being followed in the Indo-Gangetic plains.

In this concept, new crop is planted in the residues of the previous crop without any prior soil tillage or seed bed preparation. Zero tillage is applicable for soils with a coarse textured surface horizon, good internal drainage, high biological activity of soil fauna, favourable initial soil structure and an adequate quantity of crop residue as mulch. These conditions are generally found in *Alfisols*, *Oxisols* and *Ultisols* in the humid and sub-humid tropics. A wide sweep and trash bar clears a strip over the previous crop row and planter opens a narrow strip into which seeds are planted and covered.

Generally, most of the farmers practices mono-cropping system of rice cultivation. Instead of taking up second crop after *kharif* rice, farmers leave rice field fallow during *rabi* season mainly owing to lack of irrigation facilities. Therefore, in order to enhance the cropping intensity and increase farmer's income crop diversification strategies must be complemented by regular applications of organic amendments (crop residues, animal manures and composts) to maintain or improve soil quality and productivity. These strategies involved an increase in productivity through intervention of better crop production technologies and varieties, among few others. It showed 45% increase in per person food production, which has made India not only food self-sufficient at aggregate level, but also a net food exporting country. Such strategies can also be achieved by implementation of zero tillage cultivation under rice fallow land.

Advantages of Zero Tillage Operation

There are countless benefits to the land, the farmer and the environment from adopting a no-till system:

- **Soil erosion is reduced:** This helps to maintain the long-term productivity of the land. Herbicide and other chemical runoff is also significantly reduced by no-tillage farming compared to tillage farming, and no-tillage farmers do not lose precious fertile topsoil, so they don't need to add as many fertilizers to their fields as a tillage farmer practice done.
- **Less Soil Compaction:** Tillage busts up the natural soil structure. Loss of structure makes the soil less able to support heavy loads, such as the wheel traffic from tillage operations. Loss of structure also makes the soil inherently more vulnerable to compaction. Many people think that soil needs to be loosened with tillage, for water infiltration and root growth. However, after a heavy rain, tilled soil has all ran back together again – so people think that more tillage

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is needed. In the long run, tillage leads the soil becomes in ever worse condition.

- **Farmers save money and increase their profits:** Farmers no longer have to pay for the labour and the fuel that would otherwise be required forploughing.
- **Reduced fuel and equipment operation:** Because farmers practicing no-till farming do not have to run their equipment as often, they are reducing dust in the atmosphere and emissions from the equipment and are releasing less carbon from the soil into the atmosphere compared to tillage agricultural methods. Carbon dioxide isn't only greenhouse gas reduced by no-till, the release of nitrous oxide, a very dangerous greenhouse gas, is also reduced through no-till. As more nitrogen is immobilized in the soil there is a reduced need for the application of nitrogen rich manure. The farming equipment also tends to last longer because it is used less often.
- **Water Conservation:** Because no-tillage farming leaves crop residues on the land, this farming method helps to reduce the evaporation of soil moisture, absorbs more water and reduces runoff. This increases the amount of infiltration of irrigation and rainwater into the soil, which is extremely beneficial for the growth of crop plants. This is great benefit to farmers growing crops in drought-prone regions.
- **Increases in Crop Yields:** As soil fertility is built and maintained and as water is conserved within the soil, no-till farming helps to increase crop yields. However, these benefits of increased yield may take many years or even decades, to be realized when a transition from tillage to no-till farming occurs.
- **Faster Crop Maturity:** The crops are sown immediately after the harvest of the first crop when the soil is in moist condition which means they germinate and mature faster compared to systems where ploughing is done after the rains.
- **Increases in beneficial insects and soil microbes:** As the soil fertility increases, crop residue remains, and the overall soil ecology gets healthier and healthier with significantly reduced disturbance, there is typically an increase in beneficial insects and soil microbes in the soil. This increased level of beneficial insects and soil microbes supports the base of a healthy food web that can support a wide array of wildlife. When cover crops are used, they also help to increase these benefits even more.
- **Cycling of nutrients:** When the remains of the previous crops are left to rot and mix with soil, the nutrients they had accumulated is returned to the soil.
- **High Resource Availability:** There are now many resources and programs available to farmers who wish to transition and move forward with no-tillage farming.

How No-till Works ?

No-till farming, a type of soil conservation farming, prepares the land for farming without mechanically disturbing the soil. The previous year's crops, referred to as the crop residue, are chopped off and left on the topsoil. The implement basically has knife-type tines then only slightly punctures the ground to inserts a seed at appropriate depth. Unlike conventional tillage, which involves digging up to 6-7 inches, the zero-till machine does not call for any opening up of the soil. Instead, it simply slits the field by about half an inch. This helps the land retain adequate surface residues to prevent soil erosion. Zero tillage reduces water requirement of crop and the loss of organic carbon by oxidation. Farmers directly sown the seed after harvesting paddy without undertaking any ploughing operations. All they do is irrigate the standing paddy crop a few days before harvesting that make the soil in moist condition that will increase the germination percentage of second crop. The rice is harvested near to the ground so that the leftover stubble is not more than 6 inches in height. Crop residue like rice straw be used as mulching material in no-till farming also drastically increases water infiltration and therefore retention (i.e. less evaporation) by the soil.

Conclusion

After successful implementation of the technology, farmers in the village were highly impressed and motivated by the no tillage cultivation practice due to its cost effectiveness, less labour consumption, high energy saving and higher net income with efficient utilization of available resources. No tillage also helps

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in advancement in sowing on conserved soil moisture, hence, saves tillage cost, time and the soil is protected from erosion due to the retention of surface residues and increased organic matter accretion.

Fig. 1 Rice straw mulching under zero tillage cultivation of pea

Fig. 2 Zero tillage pea cultivation under rice fallow land

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11

STRATEGIES TOWARDS SMART LIVESTOCK PRODUCTION: A PARADIGM SHIFT IN NORTH EAST INDIA PERSPECTIVE

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Livestock production system in North East India is basically resource driven in the hands of small or marginal farmers and livestock rearing remains a subsistence activity with its potential for commercialization remained mostly unexploited. In majority of the states backyard rearing of micro livestock is predominant as a result the profitability and economics of production is marginal due to unscientific feeding and managemental practices. Moreover, due to drastic shrinking of the grazing land along with stagnation of crop productivity and frequent outbreak of weather extremes livestock feeding and rearing becomes challenging. Most of the animals in North East Region (NER) are low producing. To compensate the low productivity farmers generally have to maintain more number of animals which obviously increases the pressure on limited fodder resources. To popularize animal husbandry towards profitability and environmental friendly smart livestock feeding strategies are way forward to keep the livestock production system economically viable with proper utilization of available resources and make the livestock production system sustainable in the long run.

Climate smart livestock production is one of the approaches under Climate-Smart Agriculture (CSA) and was introduced by Food and Agriculture Organization (FAO) at the 'Hague Conference on Agriculture, Food Security and Climate Change' in the year 2010. It integrates the three dimensions of sustainable development (economic, social and environmental) by jointly addressing food security and climate challenges. Application of these strategies in future will be helpful to cope up and boost animal husbandry in hill ecosystem near future in this era of climate change. Some of the suggested strategies for smart livestock production are mentioned below:

1. Fodder management for smart livestock production
2. Feeding management for smart livestock production
3. Manure management for smart livestock production etc.

Among the strategies enumerated above some are practically applied in some part of North East states but some are yet to be adapted by the farmers of the region.

1. Fodder Management Strategies for Smart Livestock Production:

a) Promoting some high yielding crops

North-eastern region is a house of variety of resources. In the valleys of north east several variety of legume crops, fodder, grasses etc. are available. Promoting high yielding variety is advantageous to meet the feed scarcity during lean season eg., cowpea, stylo, leucaeana leucocephala, local grass etc. As growing multipurpose crop is advantageous as the grain can be used for human consumption while fodder can be used for animal feeding.

b) Cultivation of high biomass grass

As north eastern region is having plenty of land resources in hilly part there is scope of extensive cultivation of high biomass grass eg., dal grass, arali, georgia, napier, dinanath, blue penic grass etc. and can promote the use of these grass as livestock feed. Also the availability of these grasses during dry season can maintain the sustainability of livestock production in the region.

c) Promoting cultivation of tuber crops

Tuber crops play an essential role in backyard livestock farming of NEH tribes. As the tuber crops has the ability to adapt to soil and climatic conditions and high stor ability in the semi-processed form with high dry matter content, these crops serve as good source of carbohydrate in hill ecosystem of North East and are consumed especially during lean season. Among the tubers taro, colocasia, sweet potato, yam, tapioca etc. is

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widely used in both fresh and processed form especially for swine feeding. Also root crops are drought tolerant and needs elevated area to grow so it is most suitable for hill agriculture of north-eastern region. As it reduces the loss of nutrients to the environment so can be opt under smart feeding strategies.

d) Preservation of fodder in the form of Hay and silage

Conservation of fodder in the form of hay and silage is one of the economical smart livestock production strategies. Hay making is one of the important aspect to preserve fodder for the farmers of north eastern region for lean period with little loss of nutrients. Most of the farmers of Nagaland are conserving some locally available fodders (eg. *Borrheahispida* spp., tapioca leaves etc.) in the form of hay when availability of fodder is high during rainy season which can be fed during lean season. Farmers of the north eastern region are not practicing silage production technology. But it could be a viable alternative strategy for livestock feeding. Preparation of silage using locally available herbage, grasses, even fruit and vegetable waste can be used as a viable strategy for fodder security. Feeding of silage had shown good animal performance during fodder scarcity and hence can be a better option for smart livestock feeding. Using low cost polythene bags can be a viable option with less production cost will be beneficial and economical for small holder farmer. Also it was found that feeding of silage decreases enteric methane emission so the impact of these feed improvement intervention will be helpful under climate smart practices.

2. Feeding Management Strategies for Smart Livestock Production

a) Use of feed additives for maximizing the efficiency

The main purpose of smart livestock production is to maximize feed efficiency and reduction of livestock related environmental impact and simultaneously increase production performance. Feed additives play crucial role in achieving increased efficiency and reduced environmental load per unit of the animal product. Improved feed efficiency with the use of feed additives is one of the strategies of smart livestock feeding which not only enhances animal productivity but also reduces enteric emission intensities. It was found that in the NE region application of feed additive is very limited. Various feed additives eg., probiotic, prebiotic, organic acids, enzymes, plant secondary metabolites etc. reduce oxidative stress and act as performance promoter at the same time enhancing gut bacteria performance to stimulate immune system and also environmentally beneficial by lowering methane production.

Fig. 1 Fodder management strategies (a) Hay making (b) Silage making (c) Silage bag (d) Colocasia plant (e) Colocasia root (f) Banana bulb

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b) Improved feed processing techniques

Feed processing technologies are usually aimed to increase the bioavailability, particularly the digestibility of dietary nutrients to enhance nutrient absorption. Various methods have been developed from past few decades to increase the digestibility of low quality forages (straws, stovers) as these are necessary to rumen fill but are low in nutrient (carbohydrate) content due to the presence of ligeno cellulosic bonding. Various methods used are- Physical method (chopping, grinding, pelleting etc.), Chemical method (alkali, acid, ammonia treatment, use of oxidizing agents etc), Biological method (fungal treatment by white rot fungi, *A. cyathus, T. viridae* etc.).

c) Supplementation of area specific mineral mixture

The level of minerals in feed and fodder varies from region to region, thus mineral availability to the livestock also varies. The method of supplementing only the most deficient minerals through area specific mineral mixture by assessing the mineral content in soil, feeds and fodders and in animals in different agro-climatic zones appears to be the best approach to improve the reproductive efficiency, milk production and health of livestock under field conditions. For the livestock in hilly areas there is need of special formulation of most of the major and trace minerals as most of the soil in hilly areas is acidic and deficient in various minerals due to leaching effect during heavy rainfall. So area specific mineral mixture supplementation is one of the important strategies of smart livestock feeding.

d) Utilization of non-conventional feed resources

The cultivation and use of alternative feed resources that have high nutritive value and are adapted to harsh environmental condition therefore receive more attention. Wild under-utilized many lesser known plants with good nutritional value and high palatability are already used in some pockets of NE region and if their use as animal feed is promoted it would enhance animal productivity and in addition contributes to conservation of plant biodiversity. Some non-conventional leaves eg, *Moringa* spp., colocasia etc.; some waste from minor processing industry eg., palm oil sludge, pineapple waste, wild apple waste etc.; various aquatic plants eg., water hyacinth, aquatic weeds etc. can be used effectively in livestock feeding.

e) Development of innovative feeding by utilization of insects as meal

Utilization of insects as meal in pigs and poultry diet is one of the innovative feeding strategy for smart livestock production. Some insects eg., silkworm, eri-worm pupae, honey bees, earthworm meal, insect meal, grasshopper, beetles etc. available in plenty from silk industry, apiculture industry in various parts of North East. Insects are good source of protein and macro and micro minerals. The protein content of insects ranged from 40-60% on dry matter basis. But thorough study is needed for safe use of insects as animal feed.

Fig. 2 Livestock management strategies (a) Area Specific Mineral Mixture (b) Eri worm pupae (c) Water hyacinth (d) Stylo fodder

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3. Manure Management For Smart Livestock Production

Manure management is one of the important strategies for climate smart livestock production which will minimize the negative impact and stimulate the positive effects on the environment. Gas emission and leaching of nutrients, organic matter and odor have undesirable effects on the environment. Efficient treatment of manure can reduce the emission of green house gases (GHG) and raise agricultural productivity. To exploit the benefits of urine and to minimize nutrient losses, it is preferable to use the farm yard manure as compost. Composting of ruminant dung is also practiced in most of the nepali khutis of Assam. In Nagaland most of the rural households use swine excreta for manuring the kitchen garden which can be used as good organic fertilizer. A proposed improvement is necessary to collect and storing the manure along with keeping quality of manure without spoilage to use as organic fertilizer. Also converting manure to biogas is considered as a better option for manure management as it provides the added benefits of an alternative energy source. This option has not been well documented and practiced in North east India. Thus smart use of animal manure as fertilizer reduces the nutrient leaching from farms.

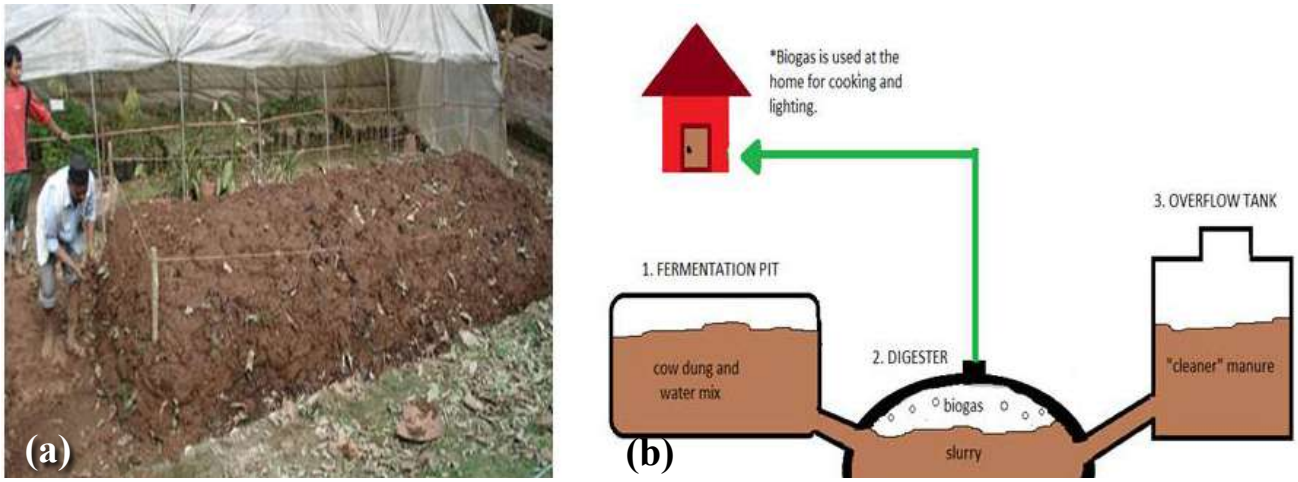

Fig. 3 Manure management strategies (a) Compost (b) Biogas plan

Conclusion

Above are the suggested strategies to improve livestock production and productivity and maintain the sustainability of livestock production system by conserving and better utilization of resources with higher feed efficiency along with reducing livestock related GHG emissions. But adaptation and application of some strategies in hill livestock production needs proper scientific intervention and institutional framework.

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DOUBLING FARMERS' INCOME THROUGH POPULARIZATION OF CLIMATE RESILIENT BACKYARD POULTRY BREEDS IN RI-BHOI DISTRICT OF MEGHALAYA: A SUCCESS STORY

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Krishi Vigyan Kendra, Ri-Bhoi, Meghalaya had introduced and popularised the climate resilient backyard poultry breeds under National Innovations in Climate Resilient Agriculture (NICRA) project for enhancing farmers income since 2011-2018 at Kyrdem and adjoining Sohriewblei villages covering 102 farmers/farm women as individual and tribal Women Self-Help Groups with Vanaraja and Kuroiler birds. Building on a social capital base is an essential requirement of backyard poultry, as it is widely spread across many households. The Self-Help Groups of women and their Federations provided the right platform for initiating the programme with the focus mainly on "Area Approach" where support systems are institutionalized on an area basis rather than on an "individual family" based approach. Three progressive farmers Mr. Colbert Shadap with 200 birds, Mrs. Biona Lymphuid with 50 birds and Mrs. Valarie Maring with 40 birds started their backyard poultry enterprise on commercial scale as an alternative source of income. The average body weight gain (114 and 62%) with their economic performance showed about 458 and 344% increase per bird in Vanaraja and Kuroiler, respectively compared with indigenous birds (Table 1 and 2).

Table 1 Body weight gain of backyard poultry breeds at different time intervals

Time intervals	Weight gain (kg bird^{-1})		
	Indigenous	Vanaraja	Kuroiler
By 4 months	0.5	1.0	0.75
By 6 months	1.1	2 .0	1.8
By 12 months	1.75	3.0	2.6
By 18 months	2.1	4.5	3.4

Table 2 Economic performance of climate resilient backyard poultry birds

S.No	Particulars	Indigenous	Vanaraja	Kuroiler
1	Average weight (kg bird^{-1})	2.1	4.5	3.4
2	Cost of rearing (Rs. bird^{-1})	210	300	300
3	Sale Price for meat (Rs. bird^{-1})	360	810	612
4	Sale price for eggs (Rs. egg^{-1})	336 (42 nos. y^{-1})	864 (108 nos. y^{-1})	720 (90 nos. y^{-1})

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5	Return (Rs. bird^{-1})	696	1674	1332
6	Profit (Rs. bird^{-1})	486	1374	1032
7	**Profit (%)**	**231.4**	**458**	**344**
8	Benefit Cost ratio	3.31:1	5.58:1	4.44:1

Fig. 1 - 4 Activities of backyard poltry farming in farmers field at R-Bhoi district

Conclusion

Farmers were economically motivated after seeing the worth of the technology and decided to form two new SHGs comprising of 20 women farmers to take backyard poultry as a venture for additional income with hatchery of fertile egg by local non-descript hen due their broodiness. However, the tribal rural farm women designated Vanaraja and Kuroiler birds as their "Credit Card" that instantly available for sale with very high demand especially for eggs and meat.

This initiative taken by KVK Ri Bhoi was able to attract farmers from the adjoining villages also because it is less capital intensive with sustainable economic returns and acts as livelihood oriented enterprise for small and marginal farmers of the district.

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13

ENHANCING INCOME THROUGH NURSERY RAISING OF VEGETABLES

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Nursery is a place where seeds are raised for better germination and growth under intensive care until they are strong enough to be planted in the main field. Nursery management is a very important process in successful production of vegetable crops, which up to larger extent determine the productivity and profitability of vegetable cultivation. Raising the quality seedlings is a specialized technique requiring skill and technical knowhow. The seeds of vegetables such as brinjal, chilli, onion, cabbage, cauliflower, broccoli, tomato, capsicum, cucumber etc. are small seeded and requires special care during their early growth period hence they are first sown in nursery beds and then transplanted in main field generally after 30-35 days of germination. The production of quality seedlings plays a vital role in the establishment of a healthy crop in the main field thereby increasing yield as well as in meeting the ever increasing demands of vegetables along with generating additional income.

Components of A Good Nursery

Selection of site

The nursery site selected should be near to the water source, sunny, well drained, free from water logging condition and other natural hazards. It should be well protected from pets/animals and a good access to the main road for easy transportation. Careful observation of site conditions and an assessment of past and present climatic records are important.

Selection of soil

Soil should be fertile, rich in organic matter preferably a medium textured loam or sandy loam soil. Slightly acidic to neutral soils with a pH 6-7 are good for raising seedlings. Proper soil treatment practices such as soil solarization or application of *Trichoderma viride* @10-25 g 100 m^{-2} area of nursery must be done to reduce soil borne pathogens, harmful pests and weeds.

Nursery bed preparation

Nursery beds can be prepared either on a flat bed, raised bed or in containers like polybags, plug trays (portrays) etc. according to the season and time. During rainy season, raised beds are preferred whereas in winter and summer season, raised as well as flat beds should be prepared. In raised beds, length of the nursery bed may be kept 3 to 5 meter however, width should be restricted to 1 m to facilitate proper light and aeration and also for easy intercultural operations. The beds are raised 15 to 20 cm high from the ground level for proper aeration in the root zones. A deep cultivation of the nursery bed followed by 2-3 hoeing is recommended. Well rotten Farm Yard Manure (FYM) @ 2 kg or 500 g vermicompost per square meter should be mixed with the nursery bed.

Seed treatment

Seed treatment with *Trichoderma viride* powder @10 g kg^{-1} of seed should be done to manage any fungal diseases. Seeds are treated with these bio-inoculants and dried under shade before sowing. Seeds should be procured from a reliable source and only healthy and vigorous seeds must be selected for sowing. For seeds sown in beds, line sowing is done as it facilitates easy weeding, drenching and removal of disease infected seedlings. After sowing, the seeds should be covered with fine mixture of sand, soil and well rotten FYM (1:1:2).

Fig. 1 Seed treatment with *Trichoderma*

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Plug/Portrays method

This method is ideal for raising high value vegetable crops under protected or open conditions. In this method, seedlings are grown as separate units containing growing media and transplanted with intact root soil. Such seedlings have better growth and establishment, appears healthy and build up a well developed root system within 25-30 days. Since the hybrid seeds of vegetable crops are expensive, this method helps in reducing cost by minimizing the seed wastage as seedlings raised through this method has lesser mortality rate as compared to the seedlings raised in beds.

Fig. 2 Seedlings raised through portrays

Fig. 3 Filling of media in polybags

Fig. 4 Transplanting seedlings in polybags

Care After Seed Sowing

Watering

Watering of the nursery beds depends upon the weather condition. Light irrigation should be given with the help of rose can till the seeds get germinated. Avoid excessive watering as the plants may die hence excess rainwater or irrigated water should be drained out from the field as and when required.

Thinning

It is an important operation to remove weak, unhealthy, diseased, insect pests damaged plants from the nursery beds. Thinning facilitates balance air and light to each and every plant.

Weed control

Timely weeding in nursery should be done to get healthy seedling. Weeds in the seed bed should be removed manually by hand or by hand hoe (Khurpi).

Hardening

Hardening is a physiological process whereby plants accumulate more carbohydrate reserves and produce additional cuticle on the leaves. In the process of hardening, seedlings are given artificial shocks by withholding watering to plant by 4-5 days before transplanting.

Fig. 5 Maintenance of seedling under low cost polyhouse

Economics

The economics of the nursery raising of King Chilli under low cost polyhouse for an area of 500 m^2 is given below:

Sl. No.	Particulars	No. of mandays/ quantity	Rate (Rs.)	Cost (Rs.)	
				Year I	Year II
1.	Labour cost :				
	A. Seed sowing in trays	2	225 manday^{-1}	450	450
	B. Preparation and Filling of media	15	225 manday^{-1}	3375	3375
	C. Transplanting	10	225 manday^{-1}	2250	2250

	D. Irrigation	10	225 manday^{-1}	2250	2250
	E. Plant protection measures	3	225 manday^{-1}	675	675
	F. Other maintenance cost	6	225 manday^{-1}	1350	1350
2.	Media cost:				
	A. FYM	3 tonnes	3500 1.5 t^{-1}	7000	7000
	B. Sandy loam soil	1 tractor load	4000	4000	4000
	C. *Trichoderma* powder	500g	50 50 g^{-1}	500	500
3.	Seeds	40 g	30,000 kg^{-1}	1200	1200
4.	Polybags	10 kg	120 kg^{-1}	1200	1200
5.	Plastic baskets/trays	100 nos.	60 piece^{-1}	6000	-
6.	Low Cost Polyhouse	01 no.	-	65,000	-
7.	Nursery tools:				
	A. Watering can	05 nos.	250 can^{-1}	1250	-
	B. Secateur	02 nos.	350 piece^{-1}	700	-
	C. Sprayer	01 no.	1500 piece^{-1}	1500	-
8.	Total cost			98,700	24,250
9.	**Gross Return:** Sale of seedlings	7500 nos.	10 seedling^{-1}	75,000	75,000
10.	**Net Return**			-	50,750
11.	B:C ratio			0.76	3.1

Conclusion

Nursery management is a labour intensive activity as nursery plants require due care and attention after emerging from the seeds. Skilled and permanent labour engagement ensures quality seedling production and maintenance in nursery.

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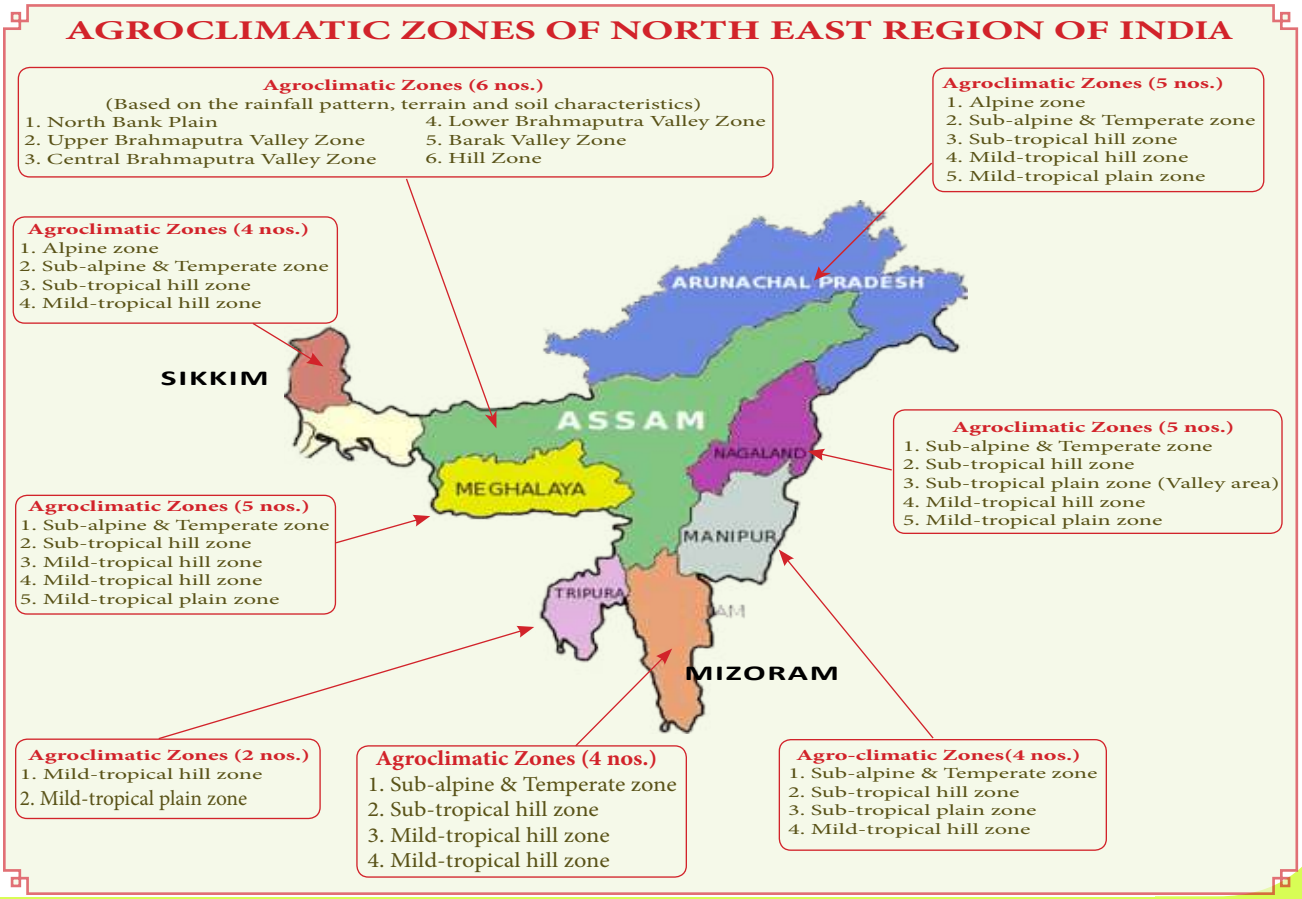

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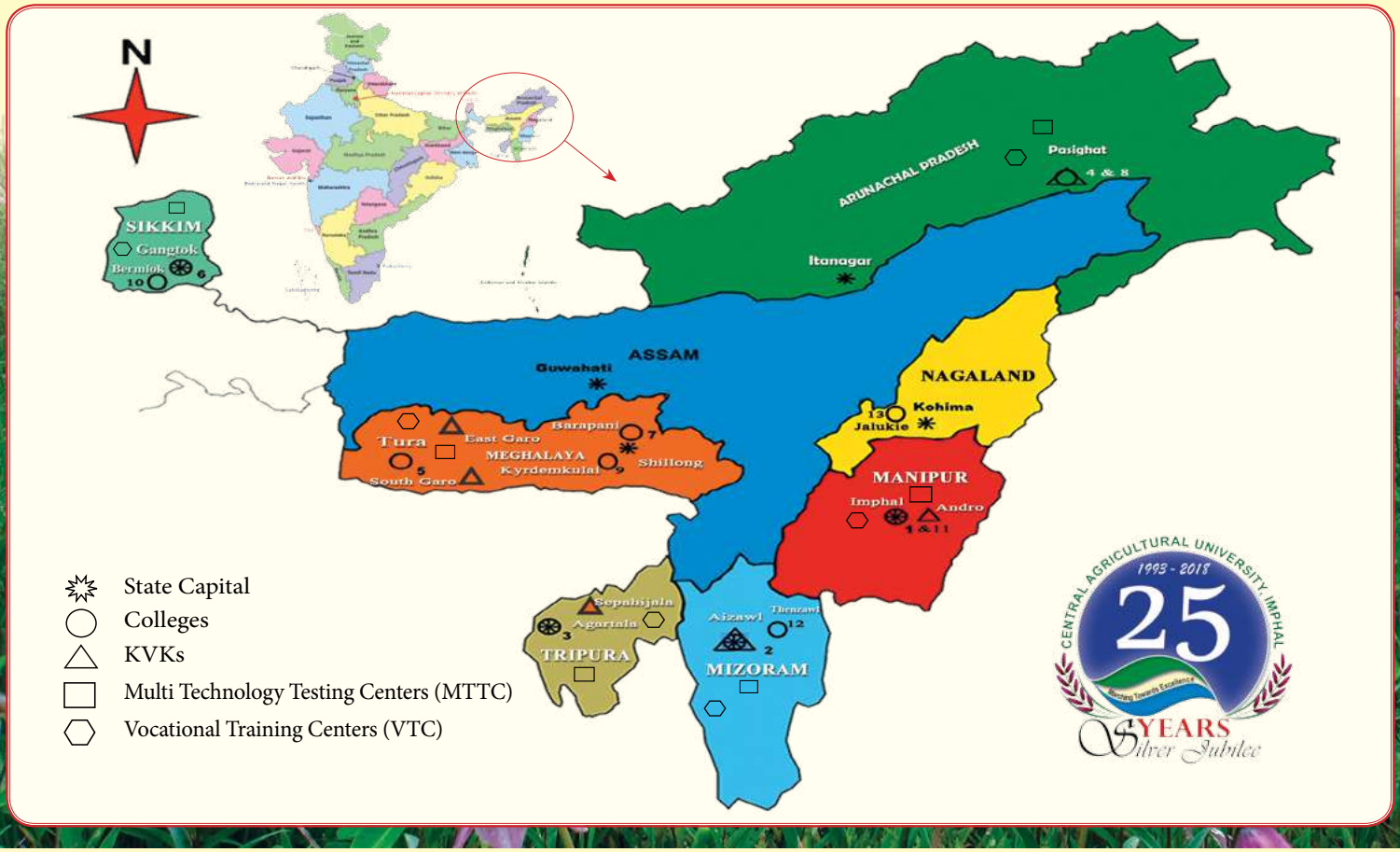

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15. Krishi Vigyan Kendra, Aizawl, Mizoram
16. Krishi Vigyan Kendra, East Siang, Arunachal Pradesh
17. Krishi Vigyan Kendra, East Garo Hills, Meghalaya
18. Krishi Vigyan Kendra, South Garo Hills, Meghalaya
19. Krishi Vigyan Kendra, Sepahijala, Tripura

O Colleges (Total 13) * State Capital

△ KVKs (Total 6)

⬡ Vocational Training Centers (Total 6)

▭ Multi Technology Testing Centers (Total 6)

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